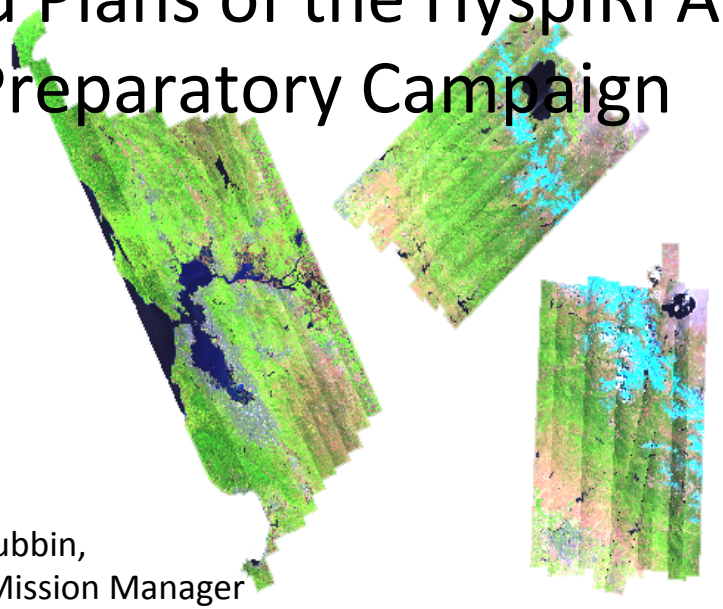
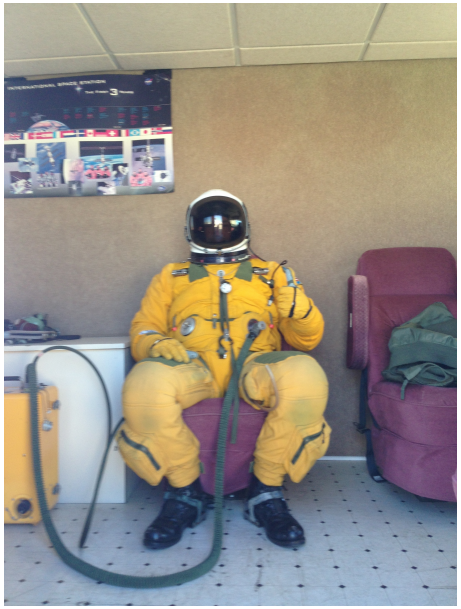
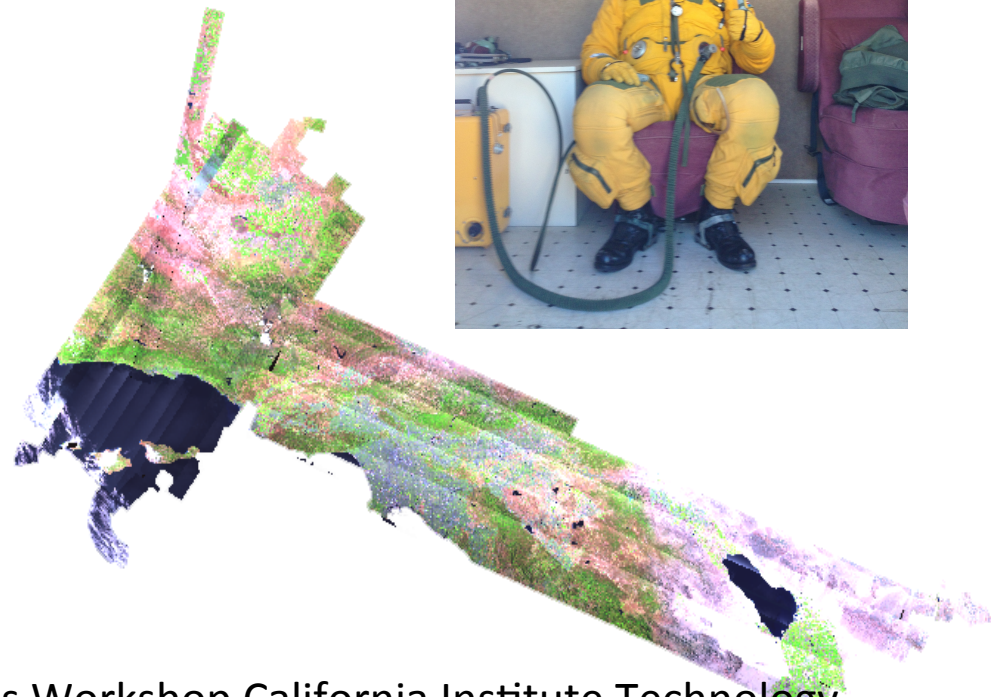
Status and Plans of the HyspIRI Airborne Preparatory Campaign





Ian McCubbin,
HyspIRI Airborne Mission Manager
Jet Propulsion Laboratory (JPL)
Desert Research Institute (DRI)

PI TEAM:
Wendy Calvin/University of Nevada - Reno
Matthew Clark/Sonoma State University
Bo-Cai Gao/Naval Research Laboratory
Bernard Hubbard/U. S. Geological Survey
George Jenerette/University of California, Riverside
Thomas Kampe/National Ecological Observatory Network
Raphael Kudela/University of California, Santa Cruz
Ira Leifer/University of California, Santa Barbara
Shunlin Liang/University of Maryland
Paul Moorcroft/Harvard University
Dar Roberts/University of California, Santa Barbara
Philip Townsend/University of Wisconsin-Madison
Susan Ustin/University of California, Davis
Jan van Aardt/Rochester Institute of Technology



2014 HyspIRI Science and Applications Workshop California Institute Technology

Name	Role
Bob York	ER-2 Engineering
Brain Rheingans	AVIRIS Telemetery Engineer
Caitlin Barnes	MASTER Engineer
Carl Sorenson	Avionics Engineer
Charles Sarture	AVIRIS Lead Engineer
Chris Miller	ER-2 Project Manager
Dan Heckel	ER-2 Maintenance - Mechanic
Dave Sermon	ER-2 Life Support
David Thompson	AVIRIS Level 2 Algorithm
David Van Gilst	Payload Systems Engineer
Denis Steele	ER-2 Pilot
Dennis Gearhart	MASTER Instrument Technician
Donald "Stu" Broce	ER-2 Pilot
Edward "Ted" Hildum	MASTER Engineer
Eric Buzay	Payload Systems Engineer
Eric Fraim	MASTER Data Analyst
Eric Stith	Payload Systems Engineer
Gerardo Rivera	MASTER Data Processing
Glynn Hulley	MASTER Level 2 Algorithms
Howard "Dean" Neeley	ER-2 Pilot
Ian McCubbin	HyspIRI Mission Manager
Jeff Myers	MASTER Instrument Lead
Jerry Roth	ER-2 Maintenance - Mechanic
Johnny Bryant	ER-2 Maintenance - Electrician
Joseph Boardman	AVIRIS Orthorectification
Josh Graham	ER-2 Life Support
Kent Dunwoody	MASTER Instrument Technician
Kevin Kraft	ER-2 Maintenance - Logistics

Name	Role
Kevin Kraft	ER-2 Maintenance - Logistics
Luis Rios	ER-2 Maintenance - Electrician
Marco Hernandez	AVIRIS Technician
Mark Helmlinger	AVIRIS Calibration
Michael Eastwood	AVIRIS Instrument Lead
Michael Kohler	ER-2 Maintenance
Mike S. Kapitzke	ER-2 Engineering
Monte Cook	ER-2 Maintenance - Electrician
Pat Lloyd	ER-2 Maintenance - Crew Chief
Patrick Grant	MASTER Engineer
Paul Everheart	ER-2 Maintenance - Crew Chief
Raul Cortes	ER-2 Life Support
Rich Weller	ER-2 Maintenance
Robert Billings	MASTER Data Analyst/Technician
Robert O. Green	AVIRIS Experiment Scientist
Rose Dominguez	MASTER Lead Data Analyst/ Coordinator
Ryan Ragsdale	ER-2 Life Support
Sarah Lundeen	AVIRIS Data System Lead
Scott Nolte	AVIRIS Technician and Calibration
Simon Hook	MASTER Experiment Scientist
Steve Johnson	ER-2 Maintenance - Mechanic
Tim Moes	ER-2 Project Manager
Tim Williams	ER-2 Pilot
Tom Ellis	MASTER Calibration Engineer
Wason Miles	ER-2 Life Support
Wendy Given	ER-2 Maintenance - Logistics
Woody Turner	HyspIRI Progam Manager
Yasha Mouradi	AVIRIS Data Processing Academic Part Time

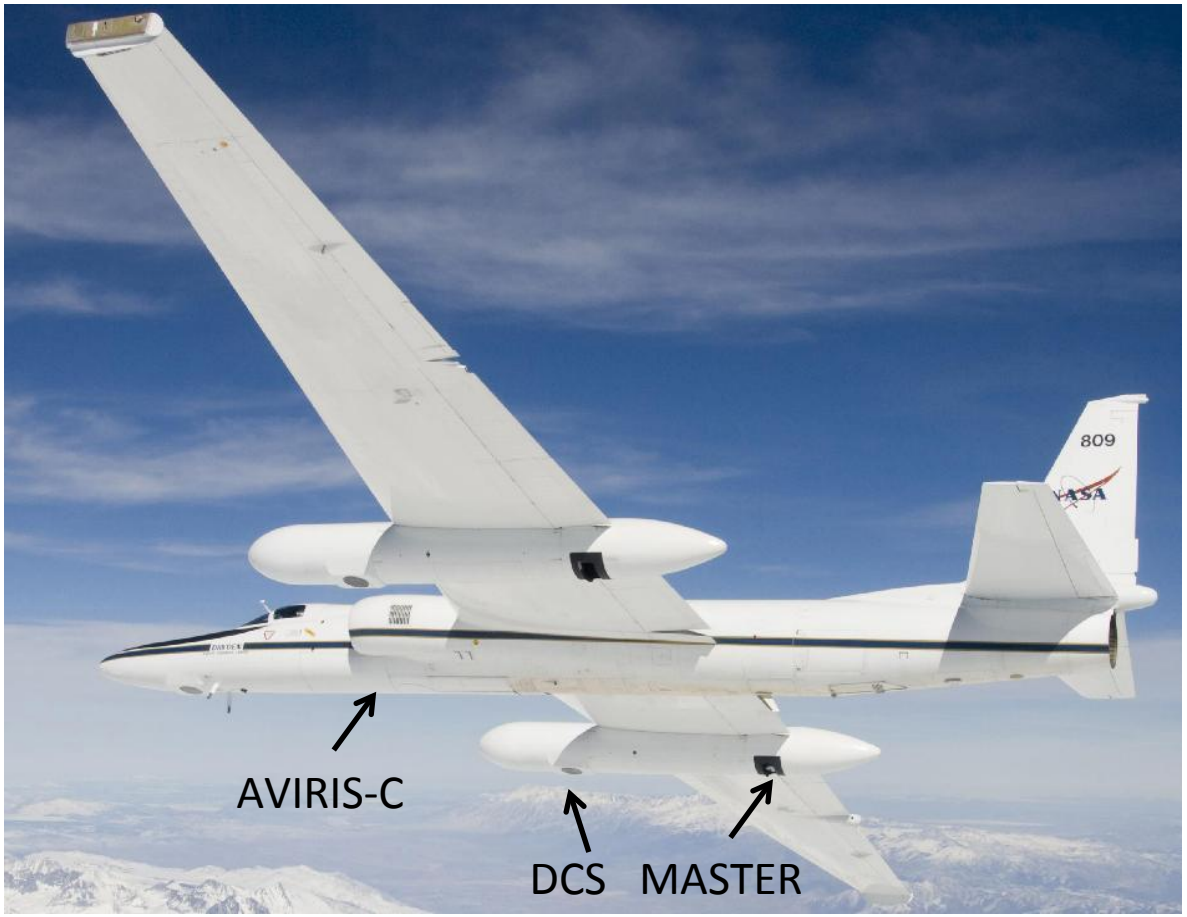
HyspIRI Airborne Preparatory Mission

AVIRIS and MASTER on ER-2 with 3 Seasonal Flights in 2013, 2014, 2015

Datasets to Simulate Future HyspIRI Satellite

Flights Over California Based from NASA Dryden (now Armstrong)

ER-2	*AVIRIS*	*AVIRIS*	*MASTER*	*MASTER*
Altitude	*Resolution*	*Swath*	*Resolution*	*Swath*
65,000 ft	*20 m*	*12 km*	*50 m*	*35 km*



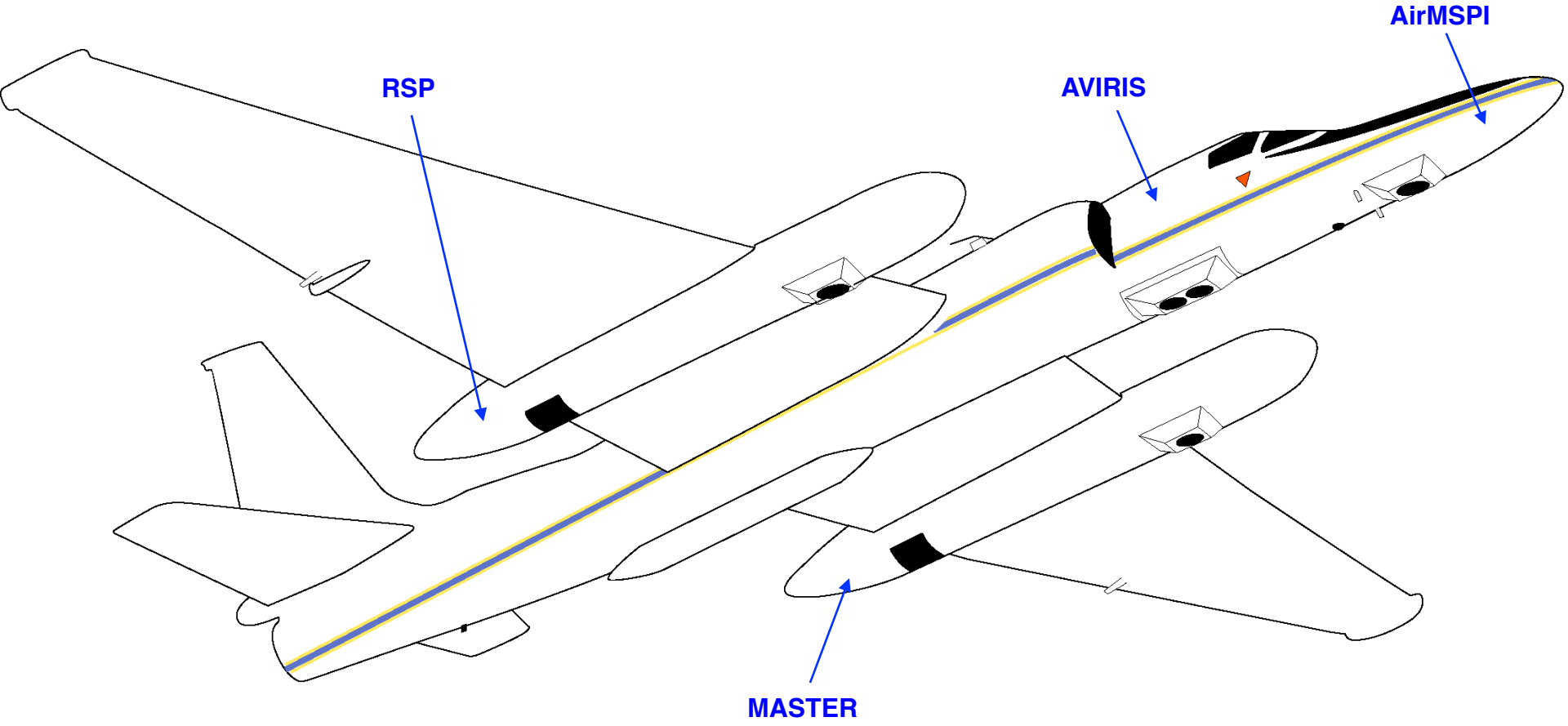
AVIRIS (VIS/SWIR)

- 10 nm spectral resolution
- 224 bands
- 400-2400 nm
- 1 mrad IFOV
- 34 degree FOV

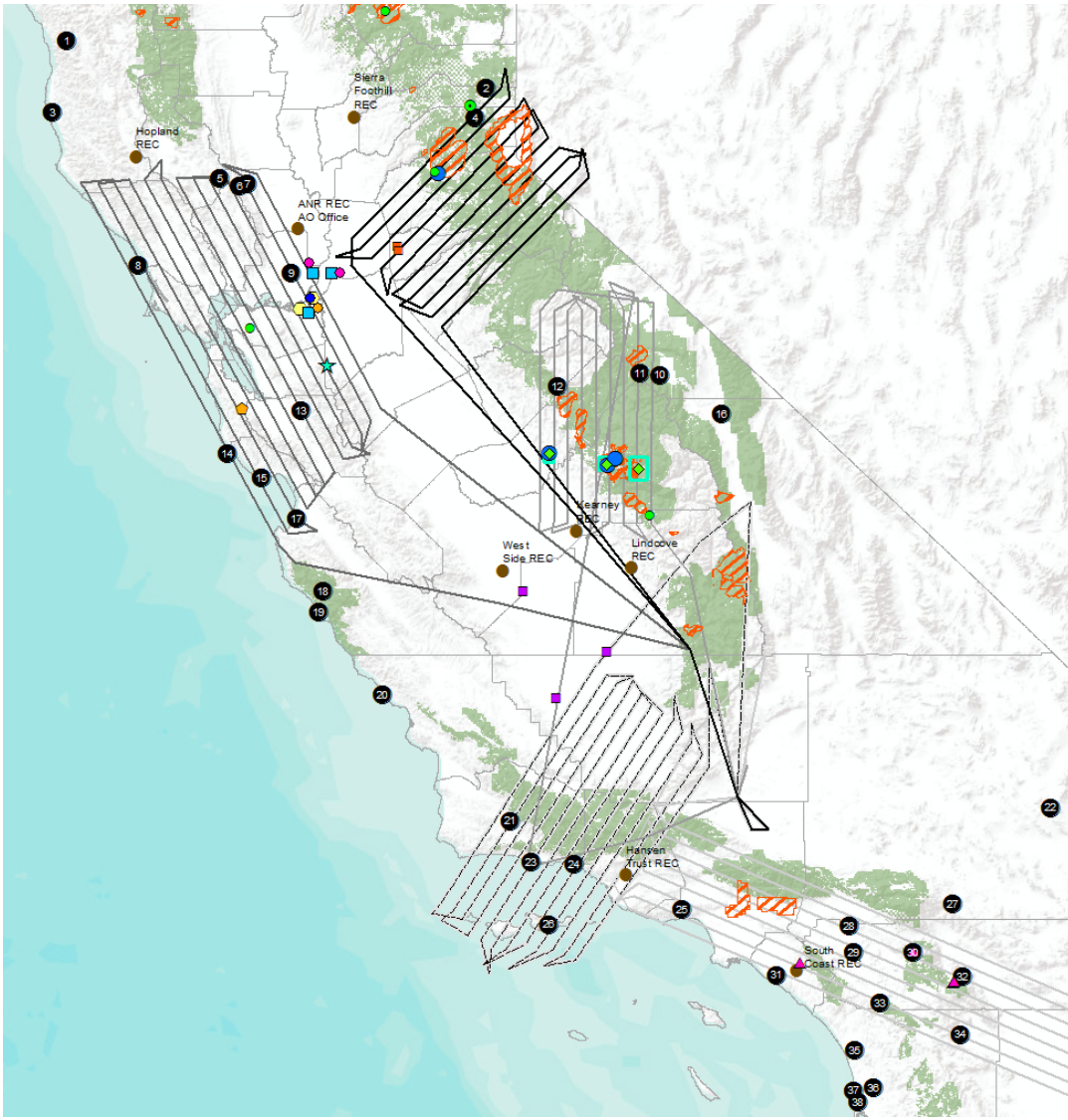
MASTER (TIR)

- 50 bands
- 0.4-13 um
- 2.5 mrad IFOV
- 85.92 degrees FOV

ER-2 Configuration



HyspIRI Airborne Preparatory Mission



3 Seasons of Collections

- Spring (April) Summer (June/Aug) and Fall (Sept – Nov)

3 Years of Collections

- 2013, 2014, and now 2015

A total of 100 ER-2 flight hours were funded dedicated to each years acquisition

- Additional Funds from NASA HQ have been sent each year to cover more hrs

Flight hours have been used to fly active fires.

- Rim Fire in 2013 over Yosemite Box
- King Fire in 2014 over Tahoe Box

Funded flight requests that participated with HyspIRI included Validation of Landsat 8, NPP Calibration, ACOCO, OCEANA, COMEX, and calibration of MASTER & AVIRIS

Piggyback opportunities for AirMSPI, RSP, NAST-I, NAST-M, S-HIS, DCS. Also, AVIRIS piggybacked on an LAC mission over the Yosemite box.

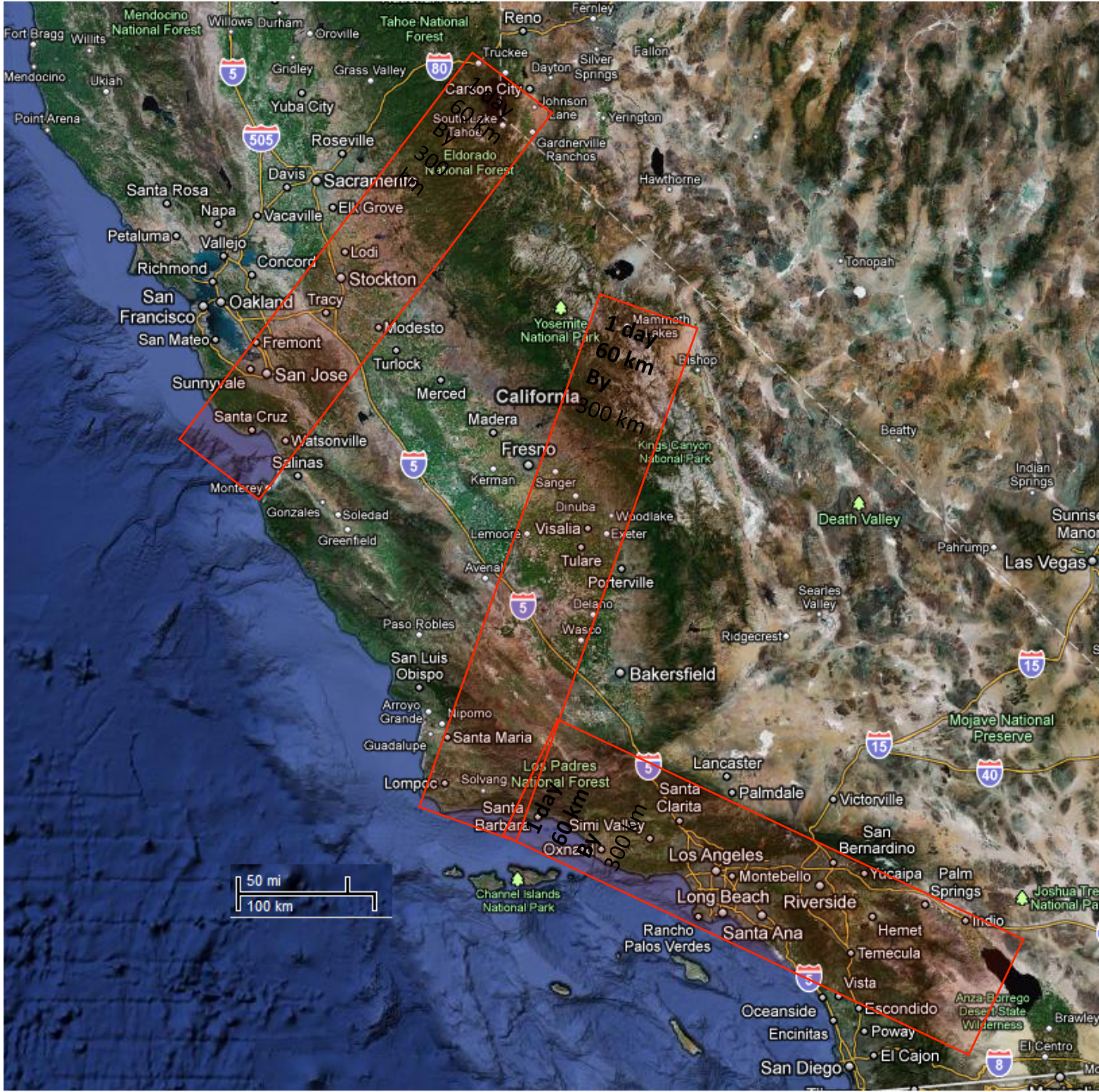
HyspIRI science and processing demonstration

3 large areas

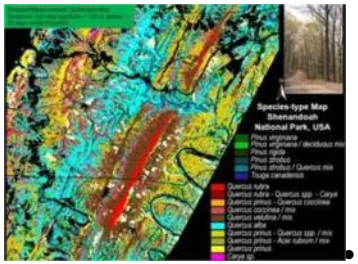
3 seasons

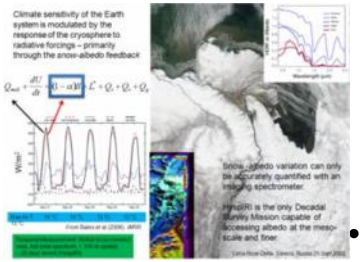
2 years

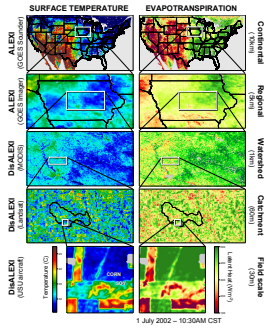
Plus selected acquisitions of" night data, active fire data, out of region opportunity volcano and coral data



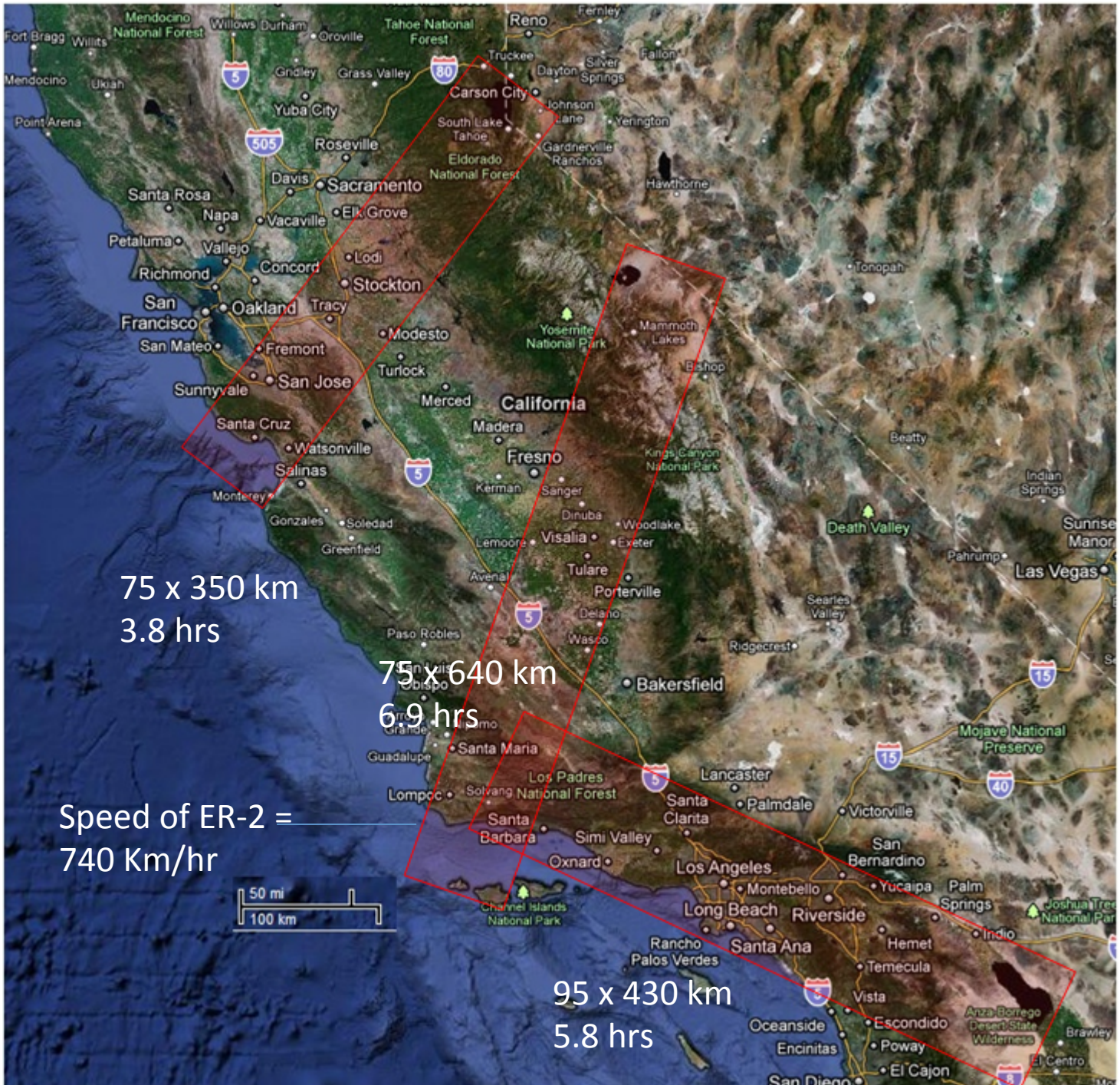
HyspIRI Decadal Survey Science and DS Climate Science Objectives







- **Key HyspIRI climate objectives from the Decadal Survey and IPCC**
  - Ecosystem Measurement for Climate Feedback
  - Black Carbon/Dust Effects on Snow and Ice
  - Carbon Release from Biomass Burning
  - Evapotranspiration and Water Use and Availability
  - Critical Volcanic Eruption Parameters
- **Imaging Spectrometer (VSWIR)**
  - Pattern and Spatial Distribution of Ecosystems and their Components
  - Ecosystem Function, Physiology and Seasonal Activity
  - Biogeochemical Cycles
  - Changes in Disturbance Activity
  - Ecosystem and Human Health
  - Earth Surface and Shallow Water Substrate Composition
- **Multi-Spectral Thermal InfraRed (TIR)**
  - Volcanoes/Earthquakes
  - Wildfires
  - Water Use and Availability,
  - Urbanization/Human Health
  - Earth surface composition and change
- **Combined Imaging Spectrometer and Multi-Spectral Thermal Science**
  - Coastal habitats, and inland aquatic environments
  - Wildfires
  - Volcanoes
  - Ecosystem Function and Diversity
  - Land surface composition and change
  - Human Health and Urbanization


75 x 350 km
3.8 hrs
75 x 640 km
6.9 hrs
95 x 430 km
5.8 hrs
Speed of ER-2 =
740 Km/hr
50 mi
100 km
Sacramento
Stockton
Oakland
San Francisco
San Jose
Fresno
Bakersfield
Santa Barbara
Los Angeles
Long Beach
Santa Ana
Riverside
San Diego
Las Vegas
Reno
Carson City
California

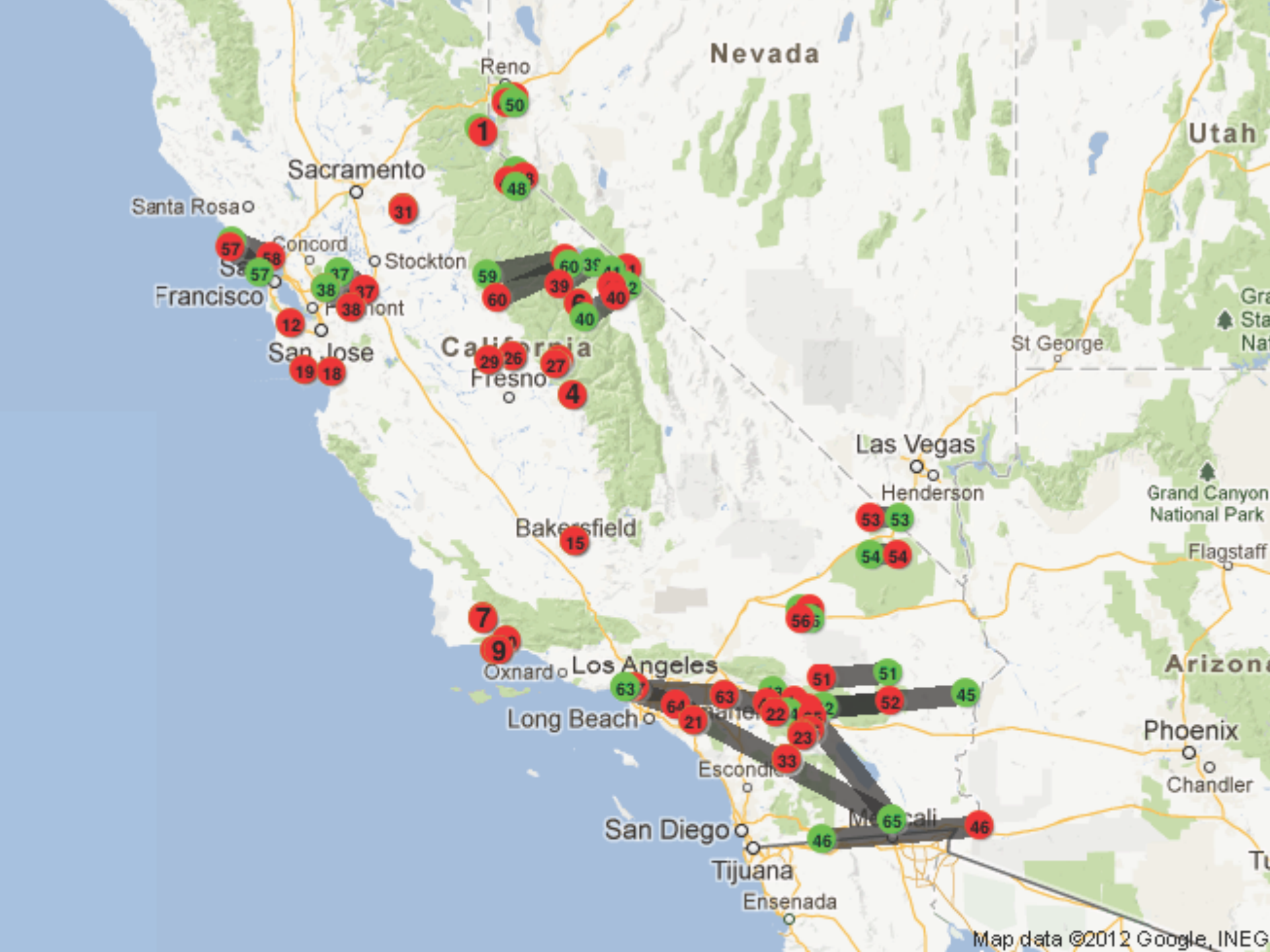
This is a rough - back of the envelope - estimate of the hours for this. assumed 1.5 hr for the climb and descent.

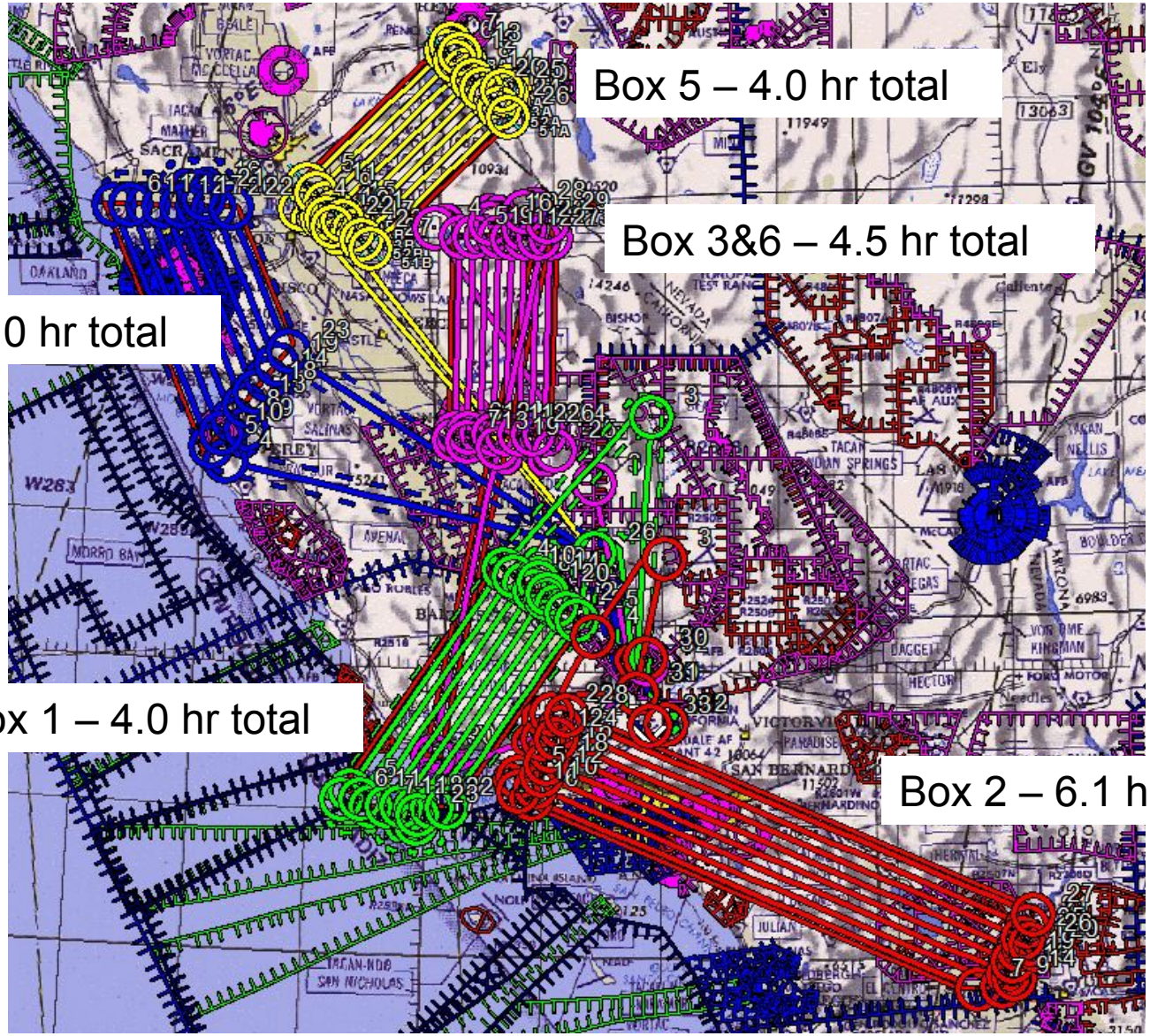
5 hr solution
3.8 hr + 0.9 hr (1 line) +1.5 hr = 6.2 hr
4.5 hr (5 line) +1.5 hr = 6 hr
1.8 hr (2 line) + 2.4 hr (4 lines) + 1.5 hr = 5.7 hr
3.6 hr (6 lines) + 1.5 hr = 5.2 hr
Total 23.1 hrs

normally use at a 1.5 to 2.0 factor to account for weather so to get this three times a year under 100 hrs, we have to be pretty good with our weather forecasts.

4 hr solution
3.8 hr +1.5 hr = 5.3 hr
3.5 hr +1.5 hr = 5 hr x 2 = 10 hr
3 hr +1.5 hr = 4.5 hr x 2 = 9 hr
Total of 24 hrs

3 hr solution
3 hr (6 lines) +1.5 = 4.5
1 hr (2 lines) + 1.8 hr (2 lines) +1.5 = 4.3 hr
2.7 hr (3 lines) +1.5 hr = 4.2 hr x 2 = 8.4 hr
3 hr + 1.5 hr = 4.5 hr x 2 = 9 hr
Total of 26.2 hrs

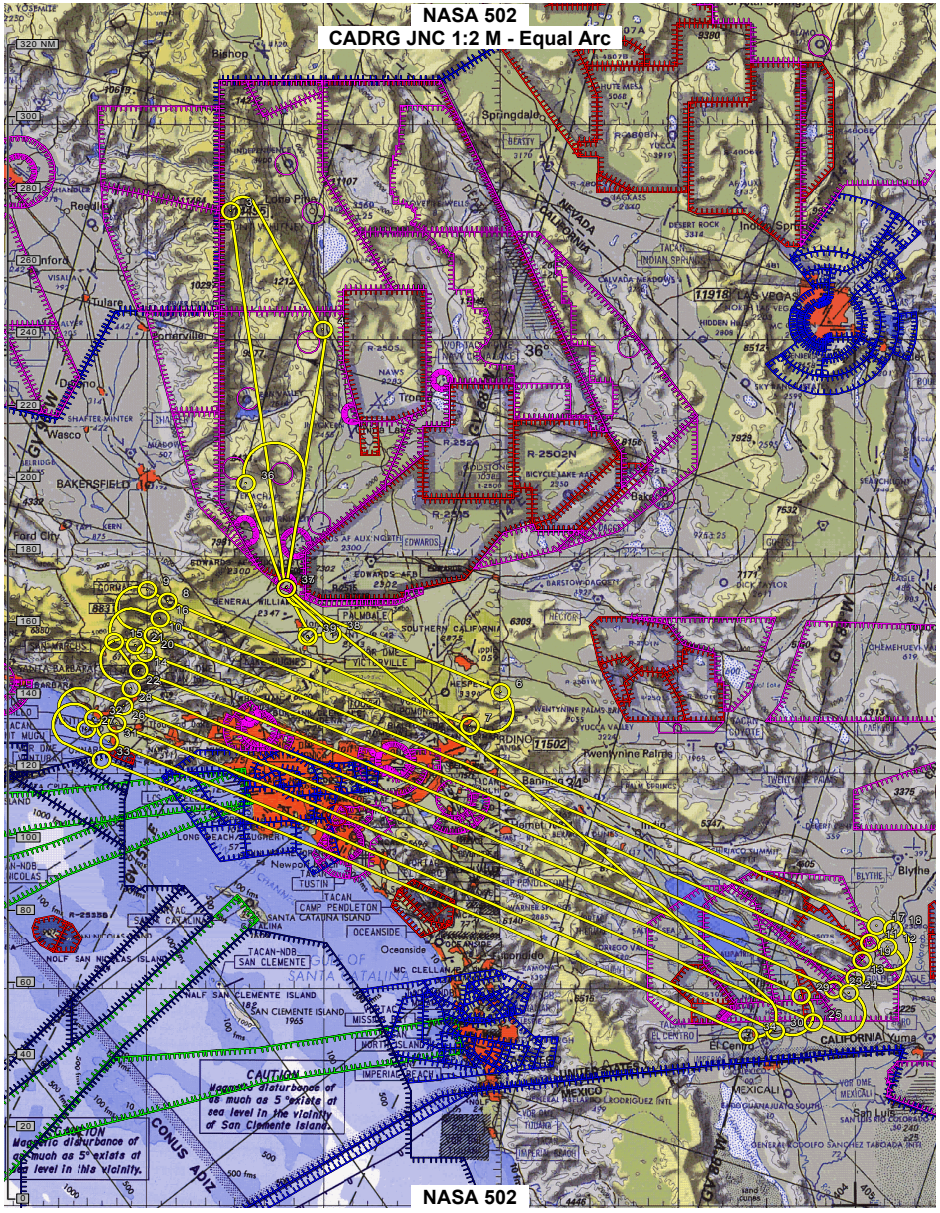

Nevada
Utah
Reno
Sacramento
Santa Rosa
Concord
Stockton
Francisco
San Jose
California
Fresno
St George
Las Vegas
Henderson
Grand Canyon
National Park
Flagstaff
Bakersfield
Oxnard
Los Angeles
Long Beach
Phoenix
Chandler
San Diego
Tijuana
Ensenada
Map data ©2012 Google, INEG


Box 5 – 4.0 hr total
Box 3&6 – 4.5 hr total
Box 4 – 4.0 hr total
Box 1 – 4.0 hr total
Box 2 – 6.1 hr total

April 19, 2013 – Southern California Box

7.6 hour Flight Time

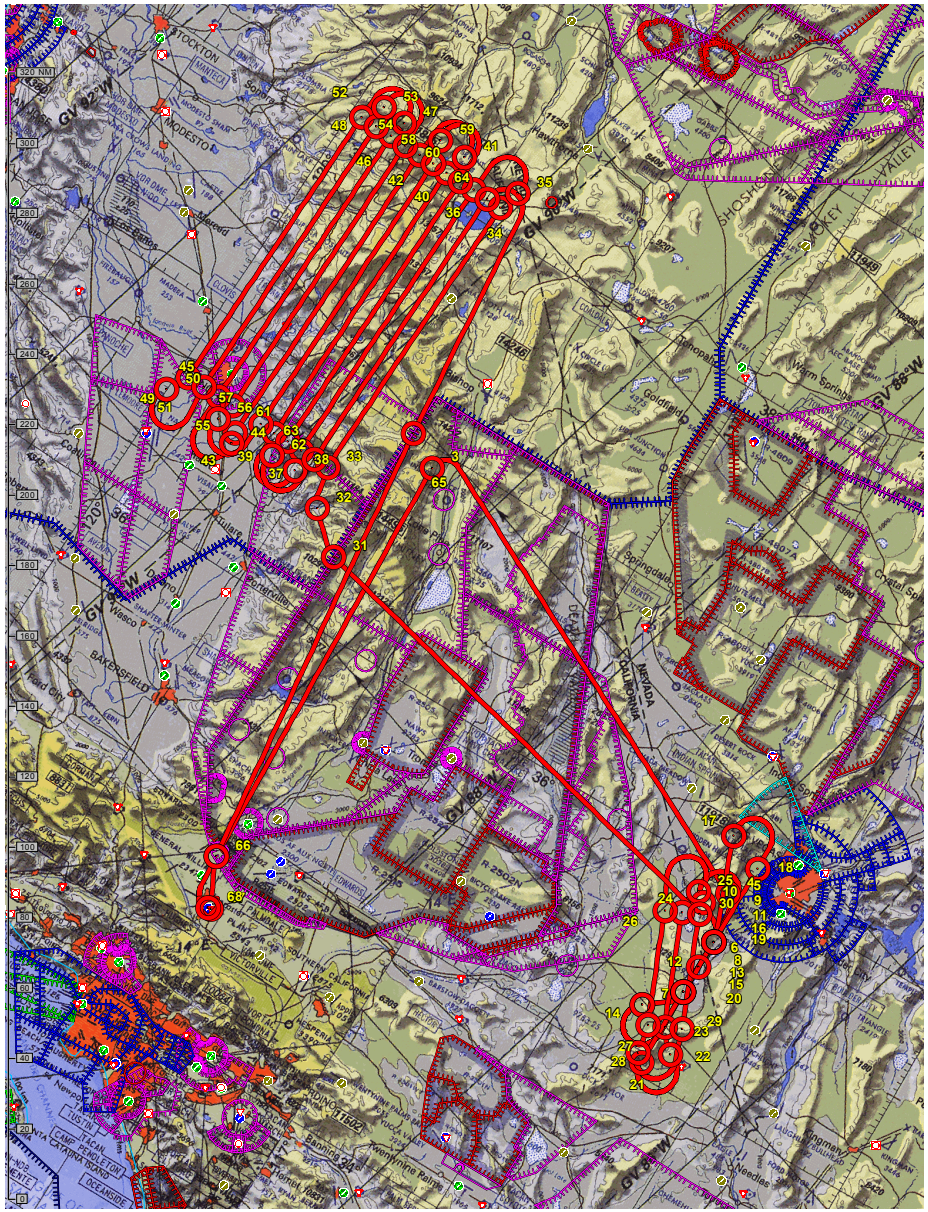
Plus: AirMSPI



May 3, 2013 Yosemite and NEON Box

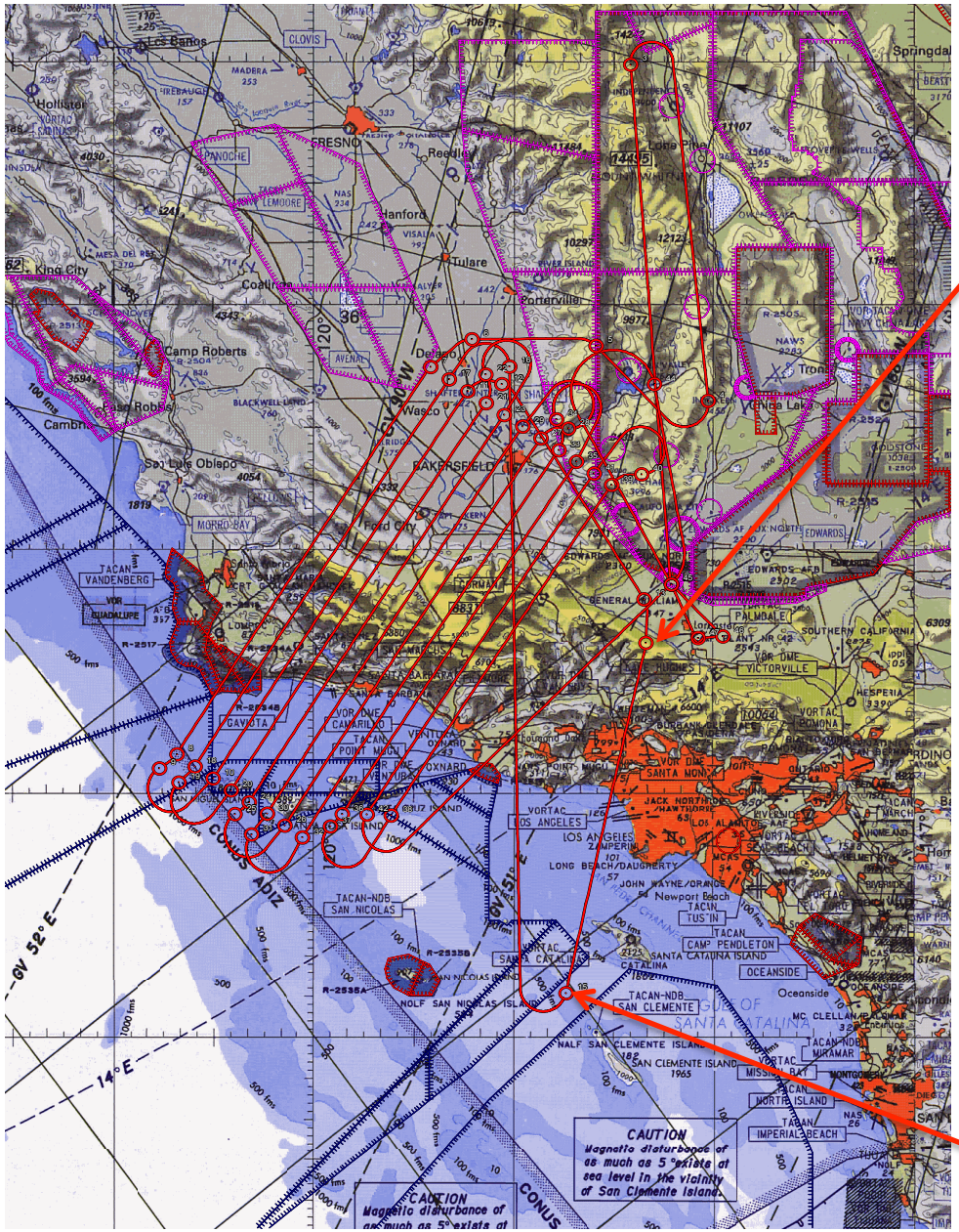
4.3 hours of Flight Time and ASO Overflight

Plus: NAST-I, SHIS, AirMSPI, & NAST-M

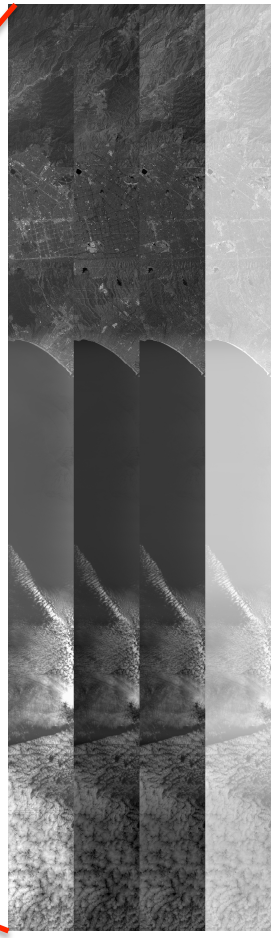


April 11, 2013 – Santa Barbara Box - 4.1 hours
Landsat 8 Under-flight over Los Angeles

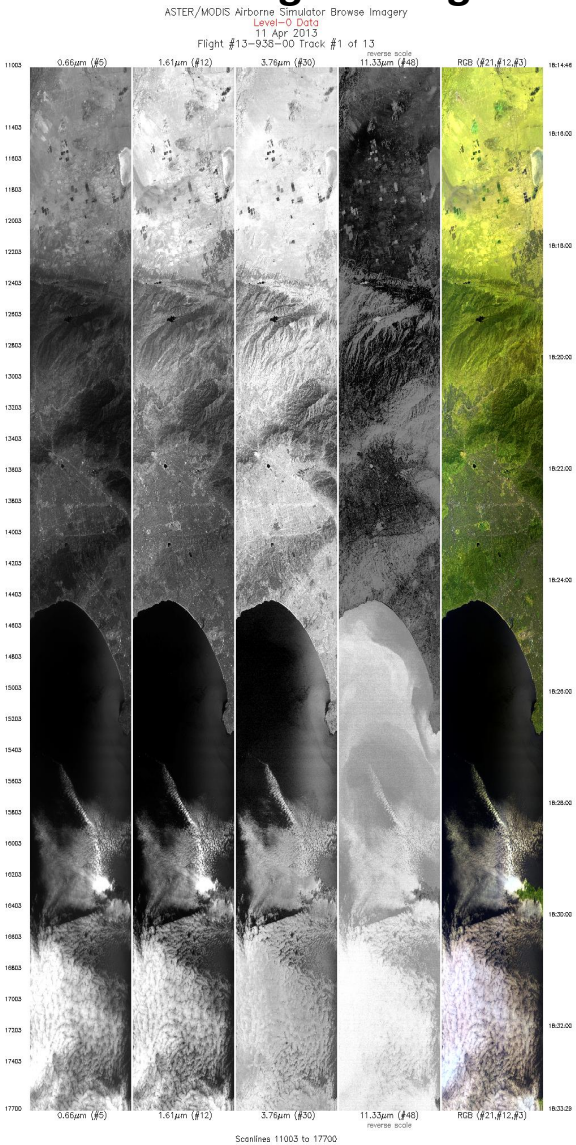
NASA/NOAA UCSB Plumes and Blumes Cruise in SB Channel During Overflight



AVIRIS Data

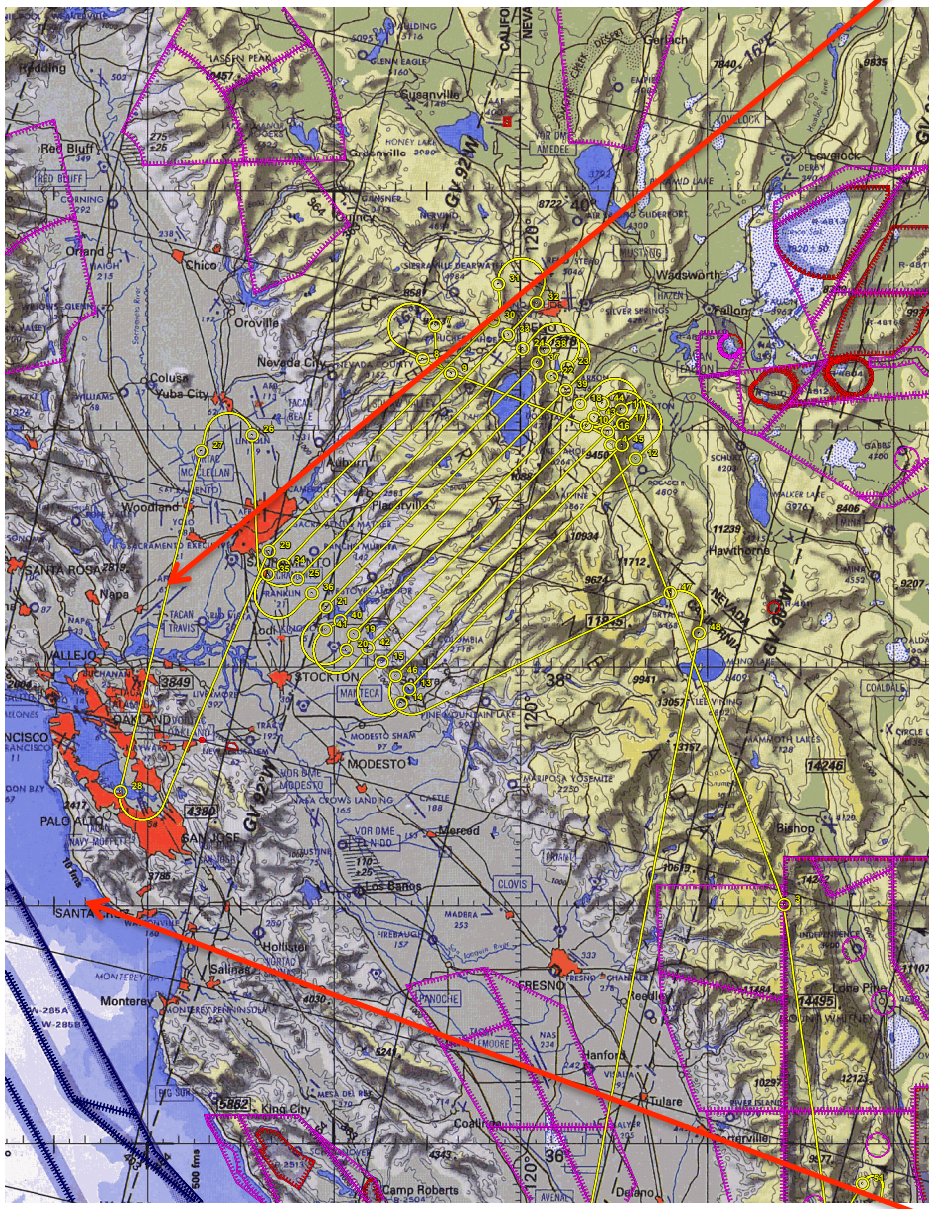


511 957 1562 2177

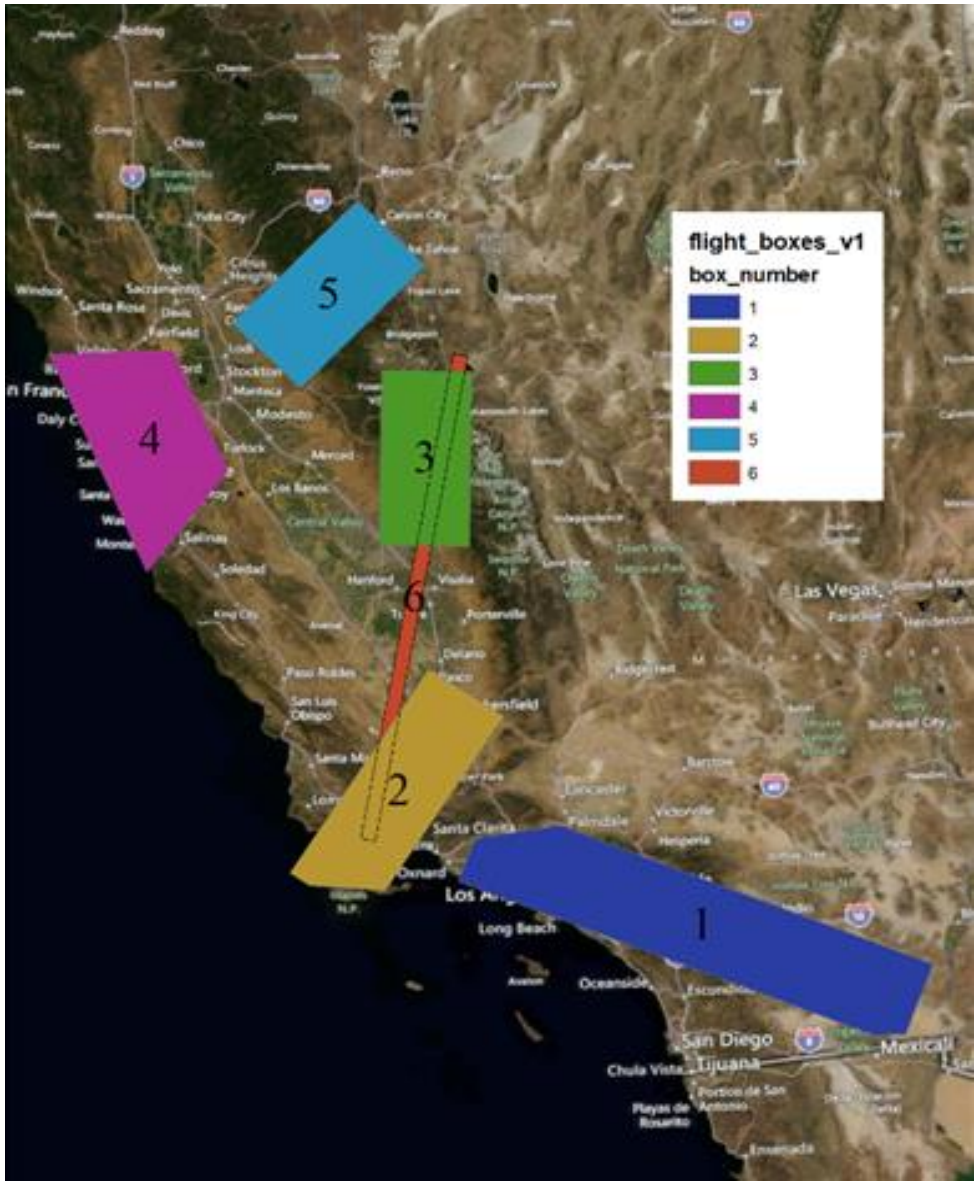


MASTER Data

May 2, 2013 – Lake Tahoe Box
Landsat 8 Under-flight over CA Delta and SF Bay
4.4 hour Flight Plus: NAST-I, SHIS, & AirMSPI


Red Bluff
Chico
Oroville
Nevada City
Colusa
Yuba City
Woodland
Napa
VALLEJO
STOCKTON
MODESTO
SAN JOSE
PALO ALTO
Monterey
Salinas
Hollister
FRESNO
Hanford
Tulare
King City
Coalinga
Camp Roberts
Delano
Bishop
Mono Lake
Lone Pine
Hawthorne
Fallon
Wadsworth
Gerlach
Susanville
Quincy
Auburn
Placerville
Los Banos
Merced
Mammoth Lakes
Coaldale
Porterville
Visalia
Lemoore
Orland
Colusa
Woodland
Napa
Lodi
Stockton
Modesto
Hollister
Salinas
Monterey
Coalinga
Delano
Bishop
Mono Lake
Lone Pine
Hawthorne
Fallon
Wadsworth
Gerlach
Susanville
Quincy
Auburn
Placerville
Los Banos
Merced
Mammoth Lakes
Coaldale
Porterville
Visalia
Lemoore
Hanford
Tulare
Camp Roberts
Delano
Coalinga
King City
Monterey
Salinas
Hollister
Modesto
Stockton
Lodi
Napa
Woodland
Colusa
Yuba City
Nevada City
Oroville
Chico
Orland
Red Bluff
Redding
Susanville
Gerlach
Quincy
Auburn
Placerville
Los Banos
Merced
Mammoth Lakes
Coaldale
Porterville
Visalia
Lemoore
Hanford
Tulare
Bishop
Mono Lake
Lone Pine
Hawthorne
Fallon
Wadsworth
Gerlach
Susanville

HyspIRI ER-2 Flight Operations



Bi-weekly call in off season and during campaigns windows.

2 PM Weather Brief Day Prior to finalize plan

6 AM Pilot Brief Day of flight to coordinate activities for mission and make final flight plan based on weather at targets

9 AM – 10 AM Take off for 4-9 hour mission

2 PM Weather Brief for next day flight

4 PM – 6 PM Mission De-brief

Download and Q/A data plus generate quicklook images to confirm successful collection

NOAA Surface Weather Observation Stations ASOS/AWOS

KSFO 151457Z 1515/1618 22010KT P6SM VCSH FEW008 SCT035 BKN050
FM151800 25008KT P6SM SCT035
FM152100 28012KT P6SM FEW025

KOAK 151442Z 1515/1618 18008KT P6SM VCSH FEW020 BKN026 BKN090
FM151900 22007KT P6SM SCT030 BKN040
FM152100 27010KT P6SM FEW035

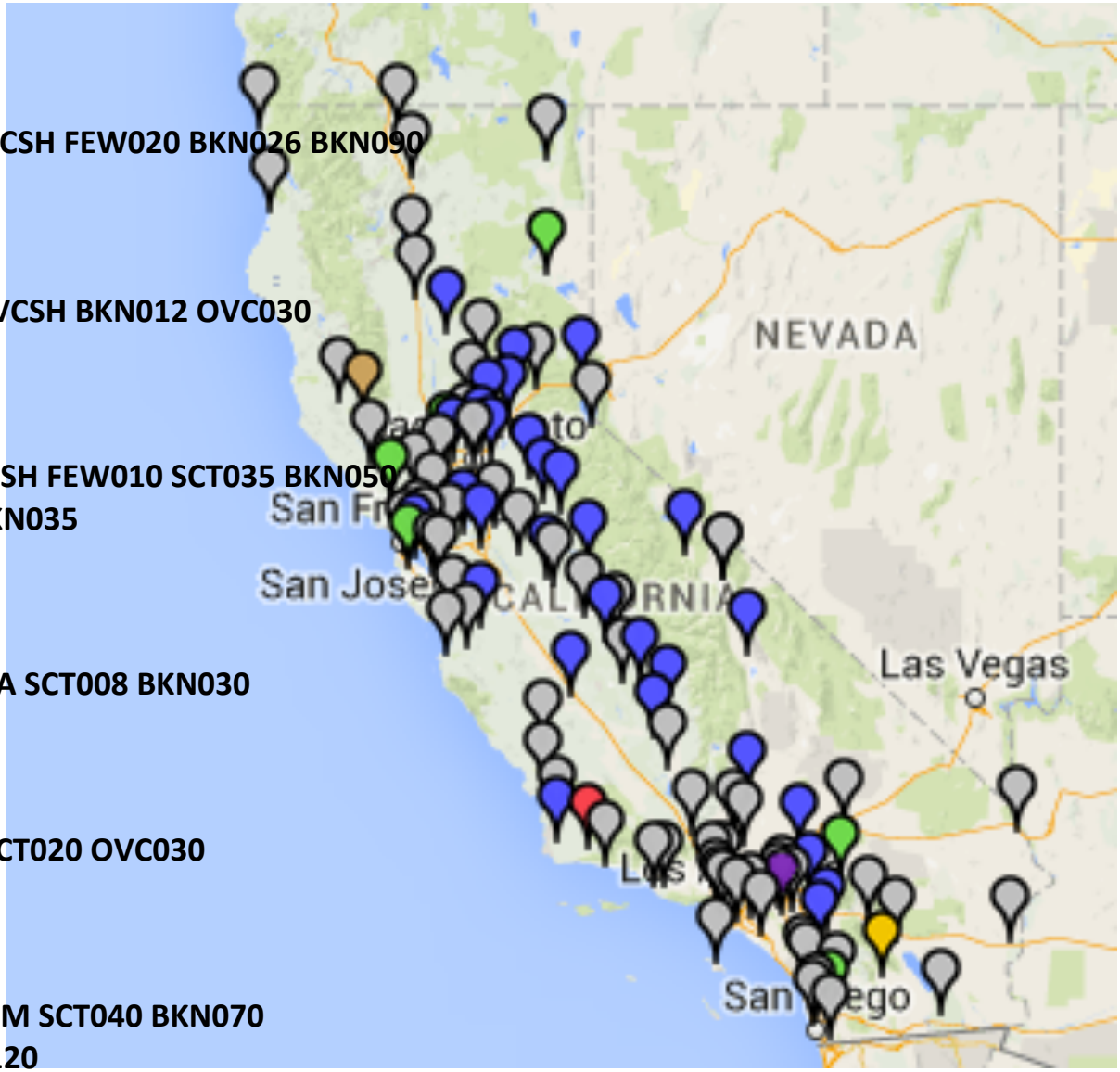
KMRY 151346Z 1514/1612 VRB03KT P6SM VCSH BKN012 OVC030
FM151600 VRB03KT P6SM SCT025 BKN035
FM151900 28008KT P6SM SCT025

KSJC 151446Z 1515/1612 17008KT P6SM VCSH FEW010 SCT035 BKN050
FM151600 17005KT P6SM VCSH FEW025 BKN035
FM151800 15005KT P6SM SCT035 BKN040
FM152100 31008KT P6SM FEW035

KSTS 151444Z 1515/1612 15004KT P6SM -RA SCT008 BKN030
FM151700 VRB03KT P6SM FEW010 SCT050
FM152100 21007KT P6SM FEW035

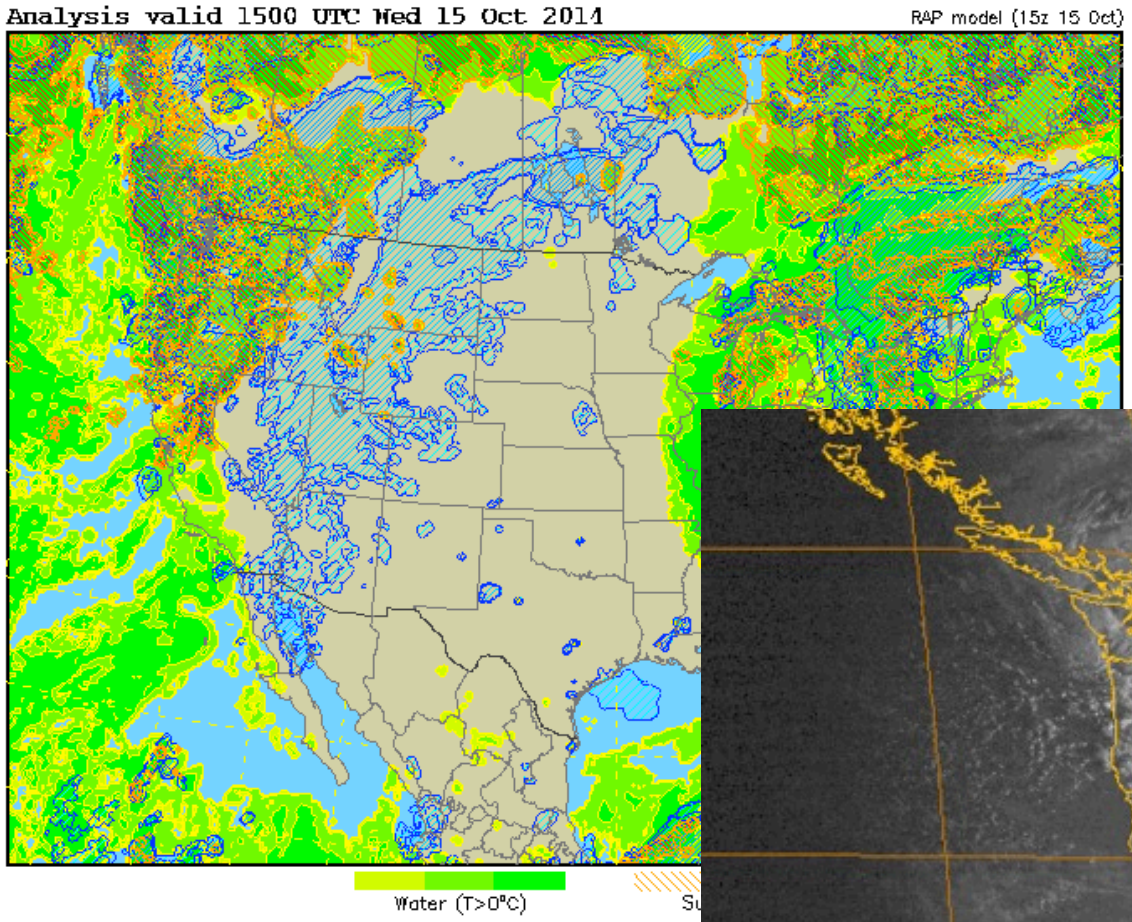
KSMF 151121Z 1512/1612 20010KT P6SM SCT020 OVC030
FM151500 20009KT P6SM SCT030 BKN050
FM151800 20008KT P6SM SCT050 BKN100

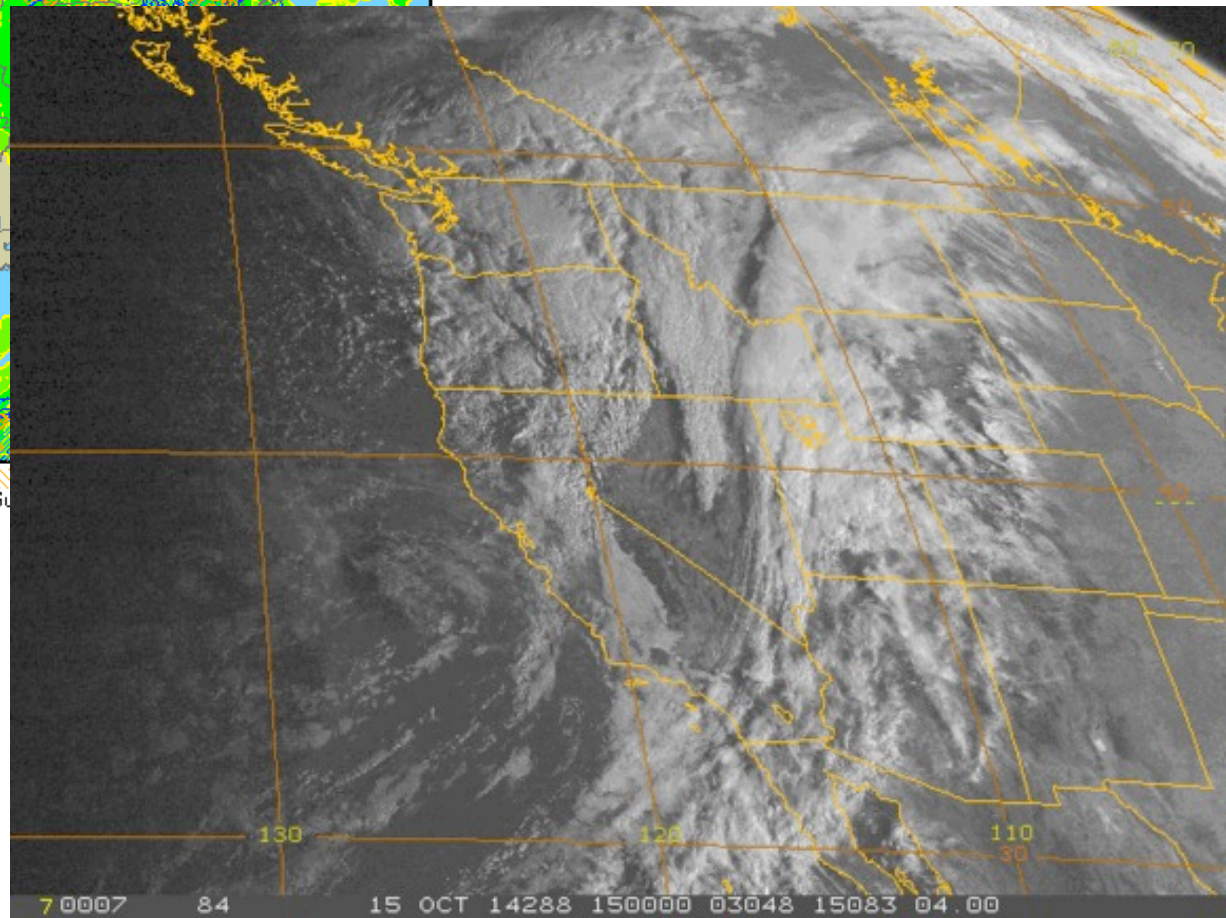
KRNO 151526Z 1515/1612 16018G35KT P6SM SCT040 BKN070
FM151700 23020G35KT P6SM SCT070 BKN120
FM152200 28012G20KT P6SM SCT120 BKN200



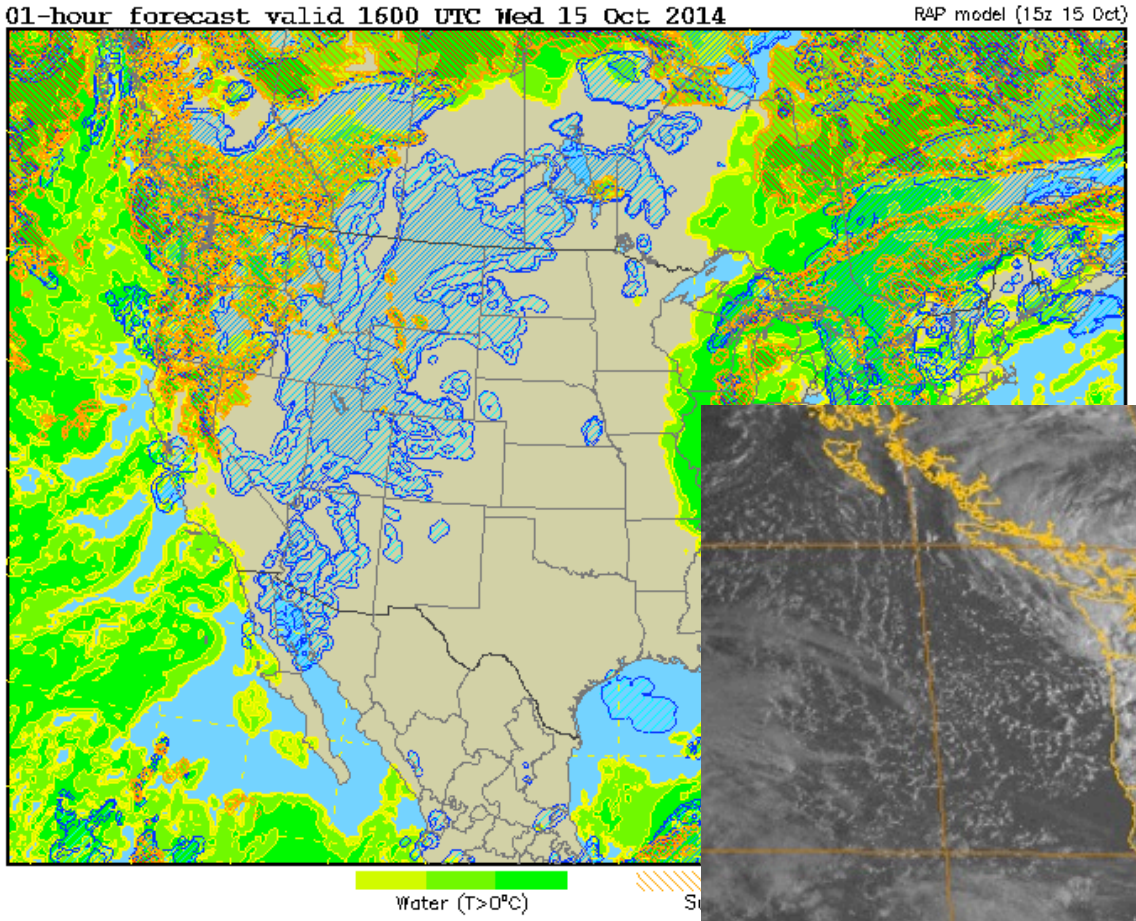
Integrated liquid and frozen hydrometeors (all levels)

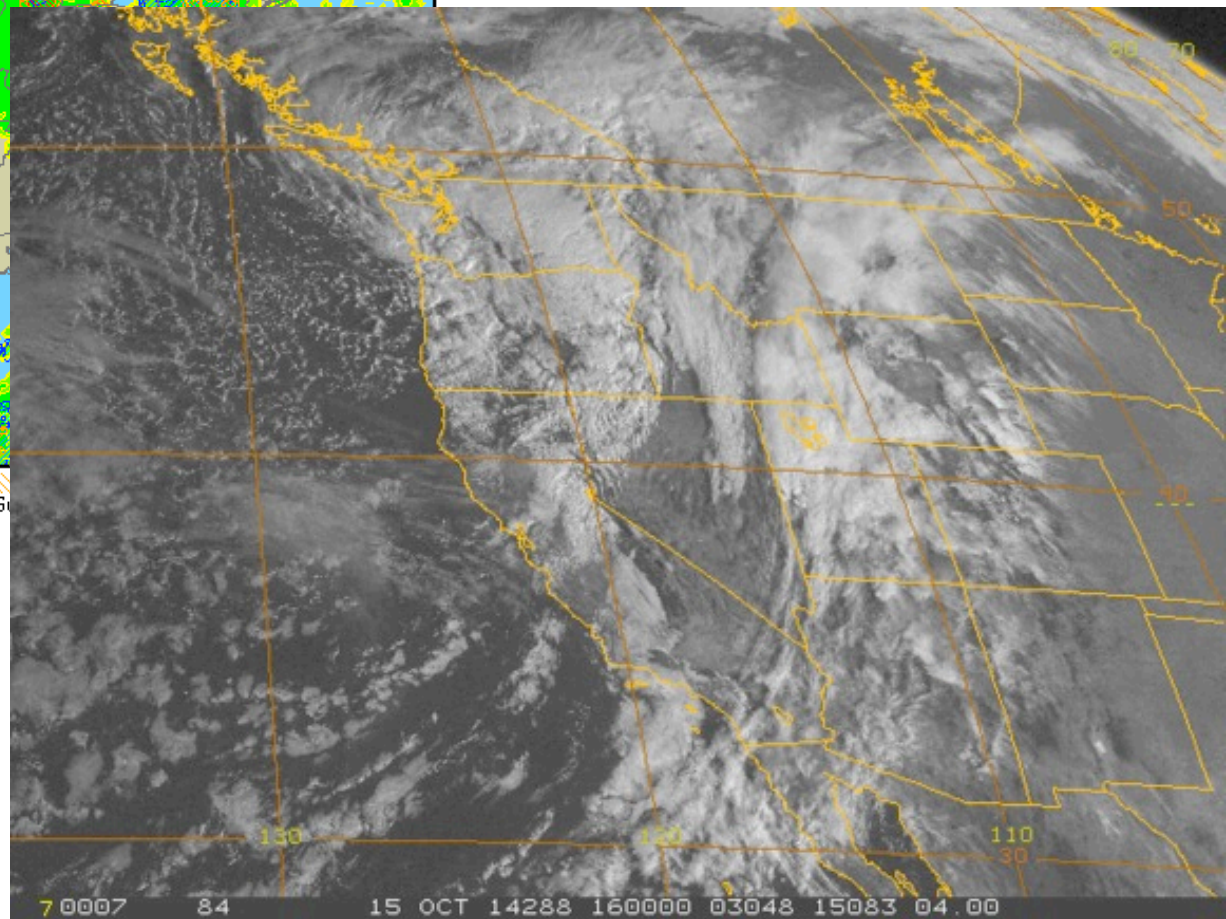
KSJC 151446Z 1515/1612 17008KT P6SM VCSH FEW010 SCT035 BKN050
KSFO 151457Z 1515/1618 22010KT P6SM VCSH FEW008 SCT035 BKN050
KOAK 151442Z 1515/1618 18008KT P6SM VCSH FEW020 BKN026 BKN090
KMRY 151346Z 1514/1612 VRB03KT P6SM VCSH BKN012 OVC030
KSTS 151444Z 1515/1612 15004KT P6SM -RA SCT008 BKN030
KSMF 151121Z 1512/1612 20010KT P6SM SCT020 OVC030
KRNO 151526Z 1515/1612 16018G35KT P6SM SCT040 BKN070



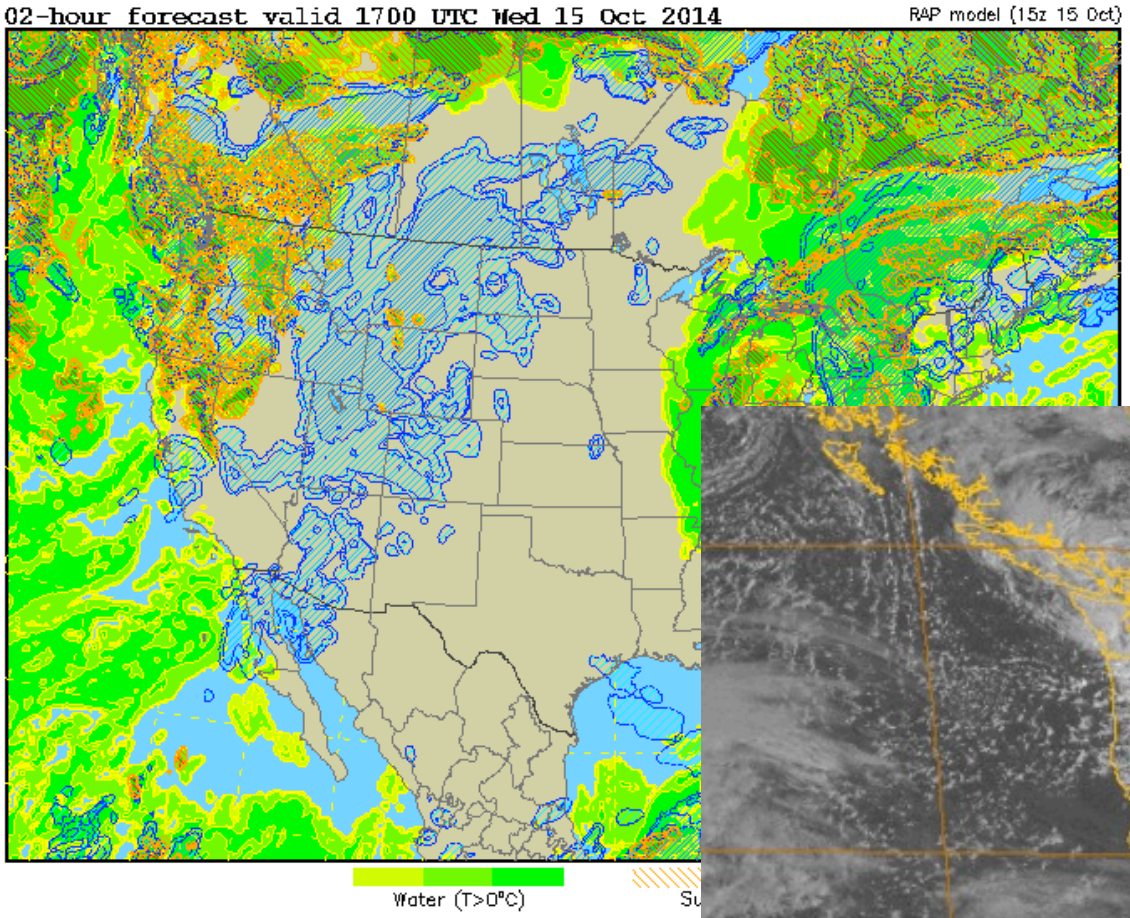


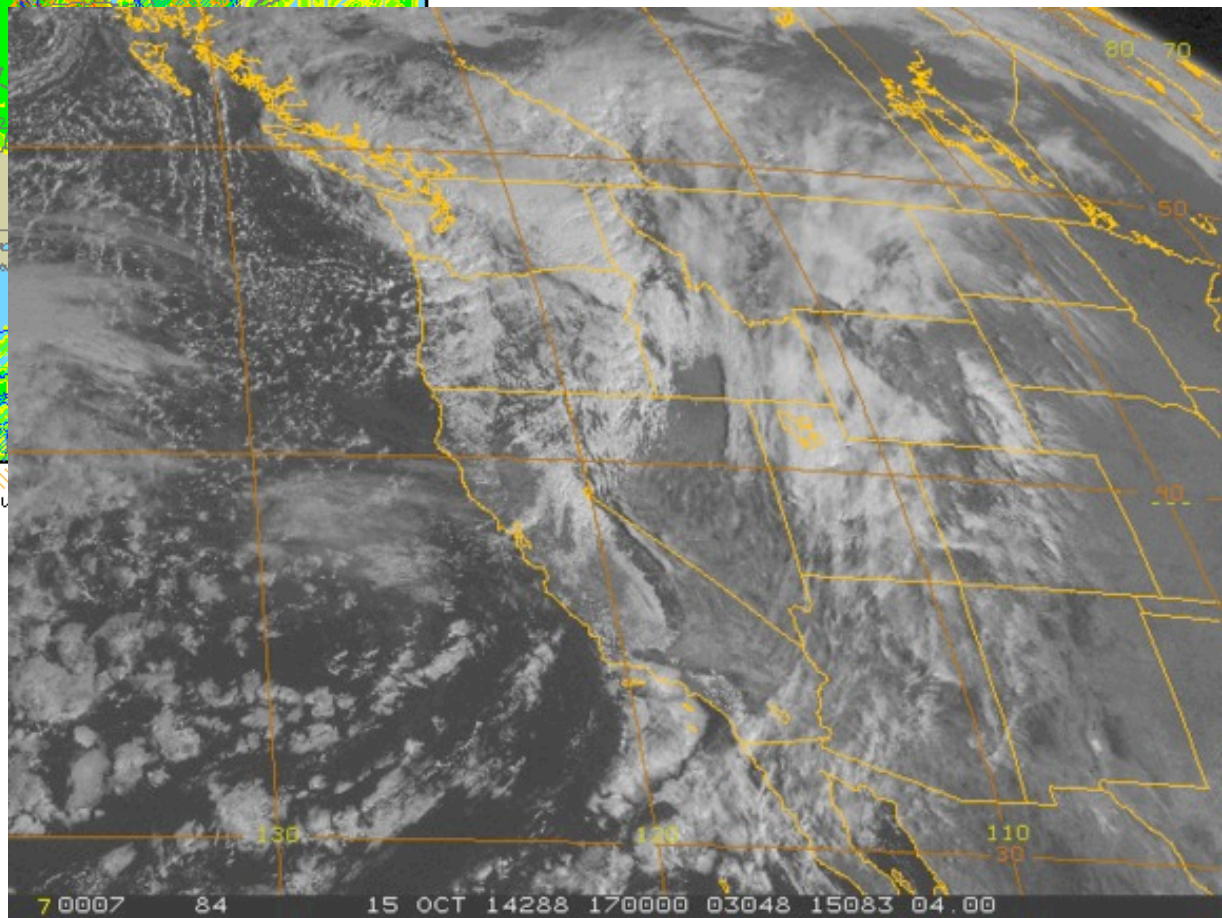
Integrated liquid and frozen hydrometeors (all levels)





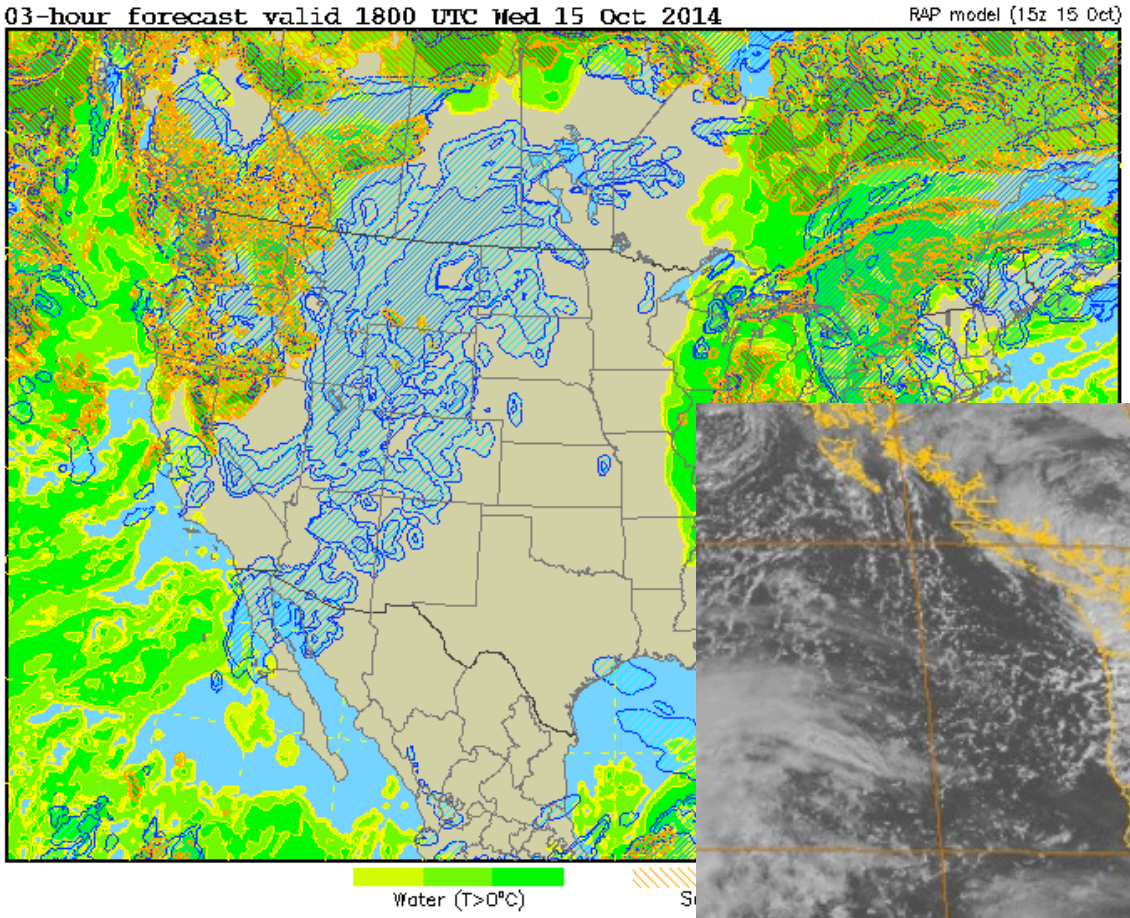
Integrated liquid and frozen hydrometeors (all levels)

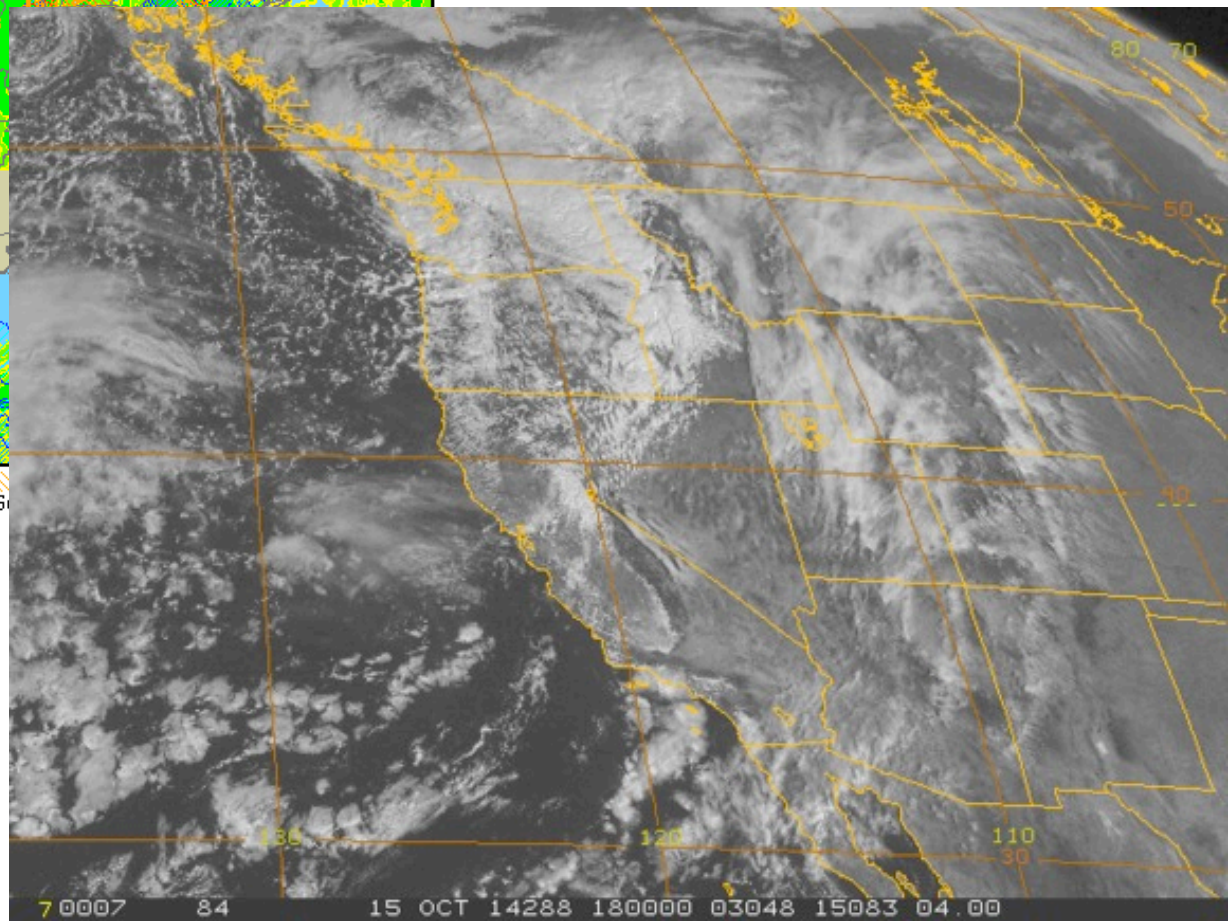




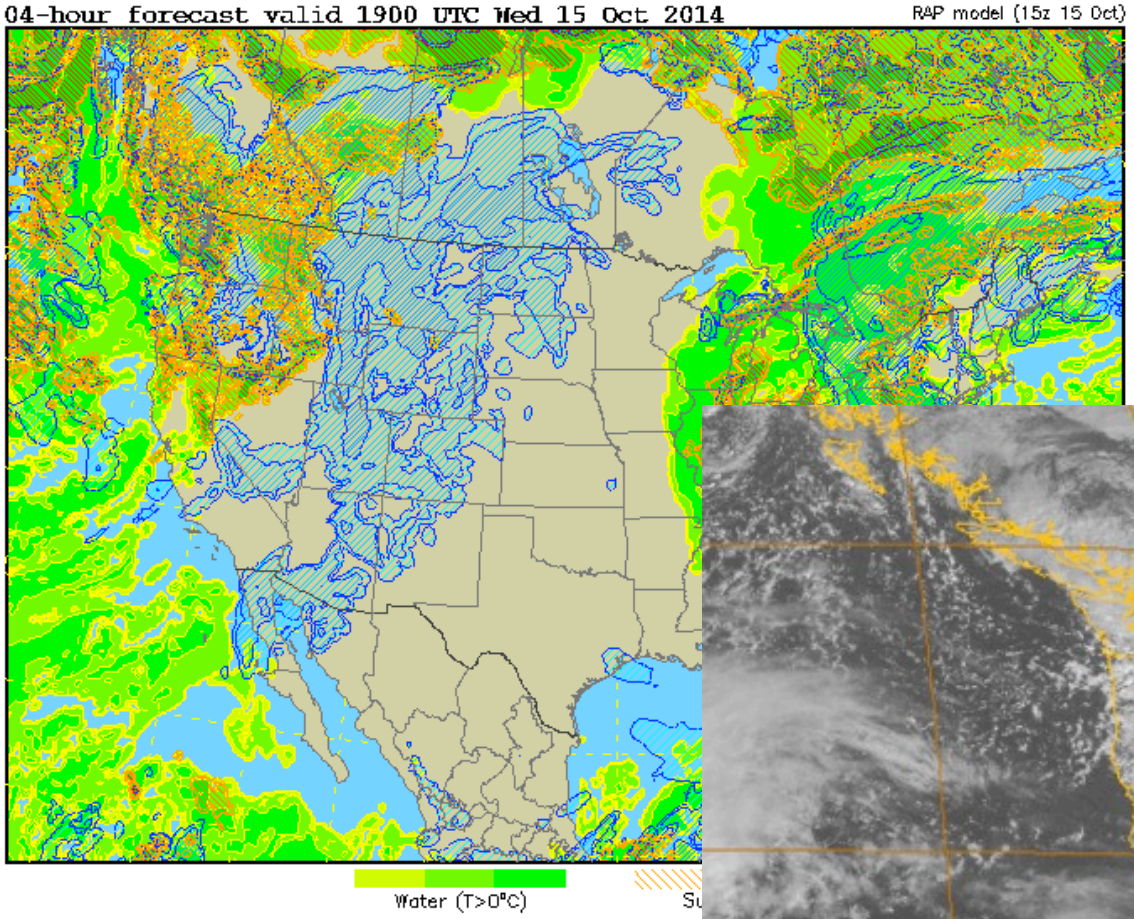
Integrated liquid and frozen hydrometeors (all levels)

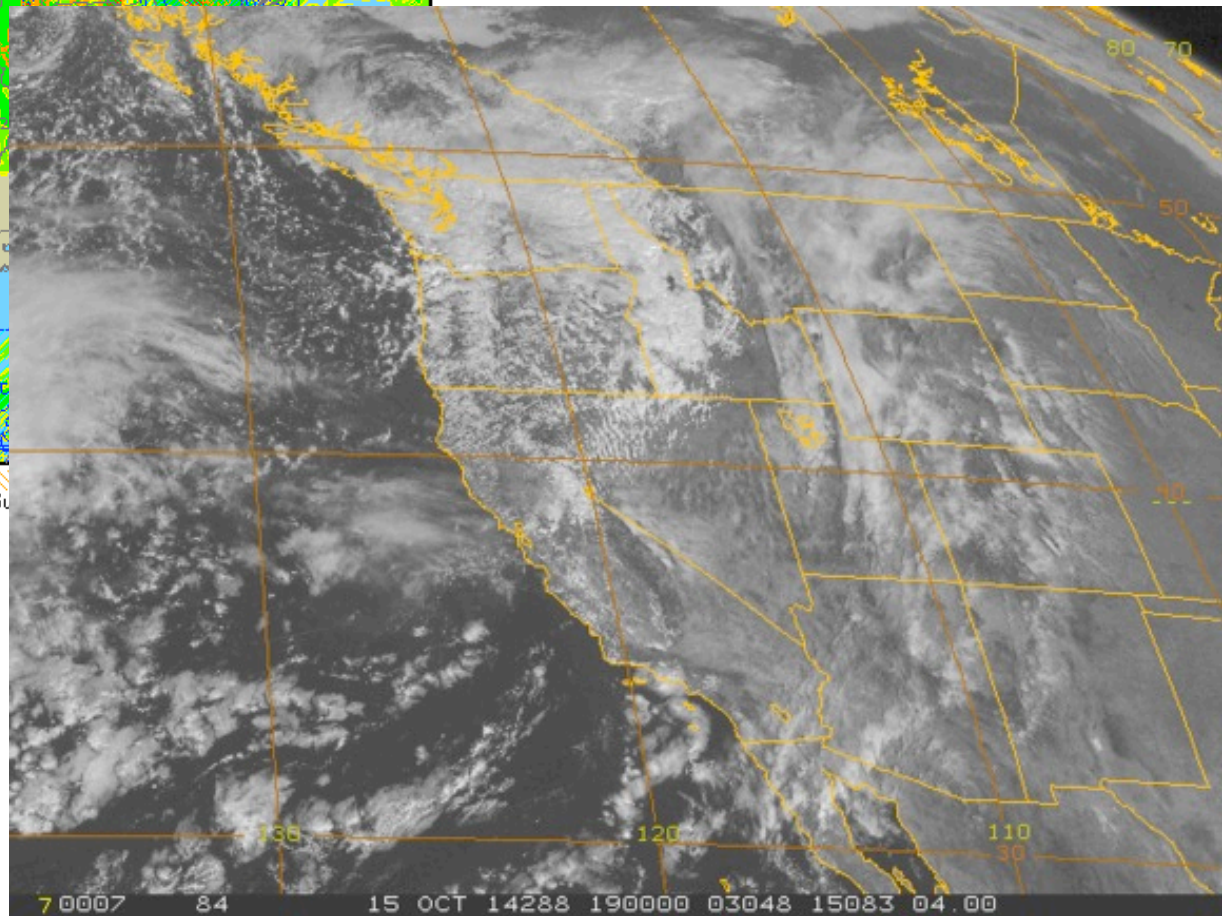
KMRY 151729Z 1518/1618 VRB03KT P6SM FEW010 SCT025 BKN045
KRNO 151739Z 1518/1618 27015G25KT P6SM SCT050 BKN200
KSMF 151720Z 1518/1618 19008KT P6SM FEW030 BKN060
KSTS 151729Z 1518/1618 VRB03KT P6SM FEW004 SCT050
KSJC 151729Z 1518/1618 11005KT P6SM FEW015 SCT025
KOAK 151729Z 1518/1624 19008KT P6SM FEW020 BKN050
KSFO 151729Z 1518/1624 21008KT P6SM FEW030 BKN040



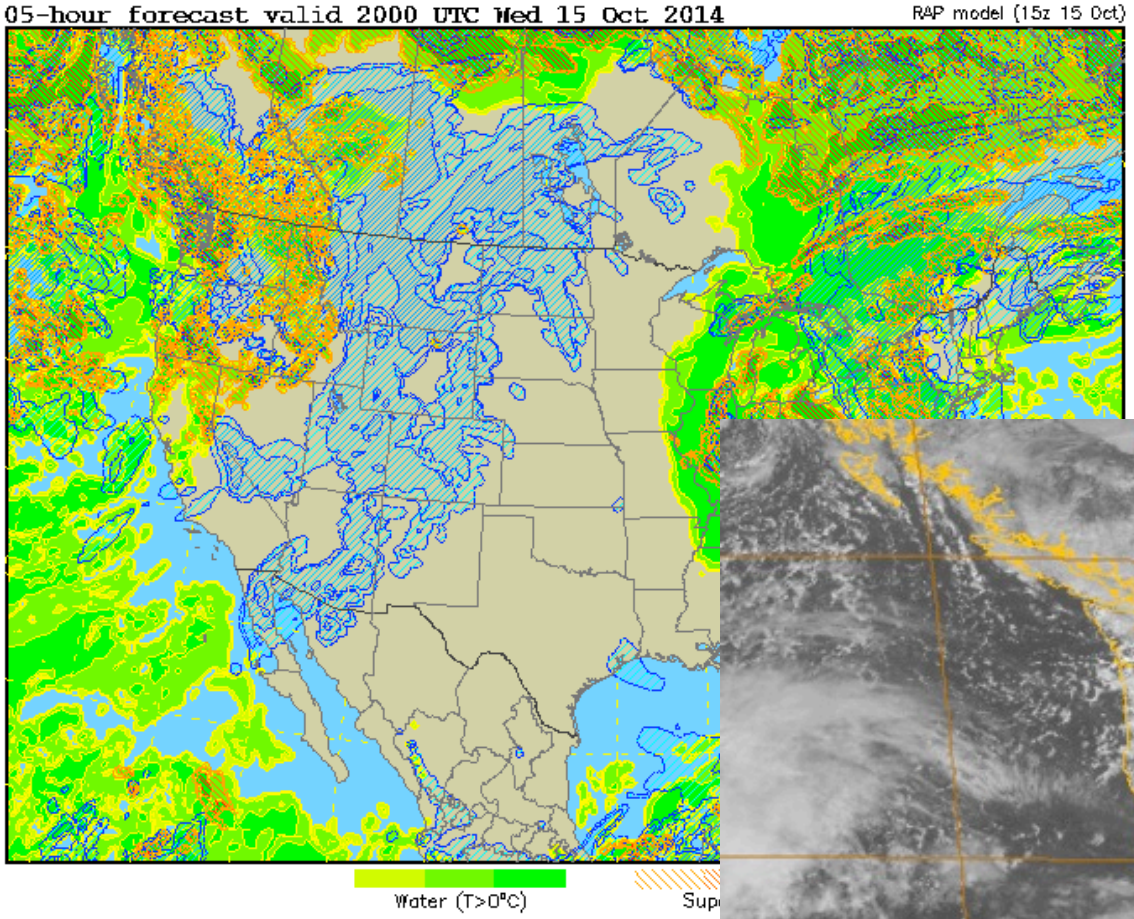


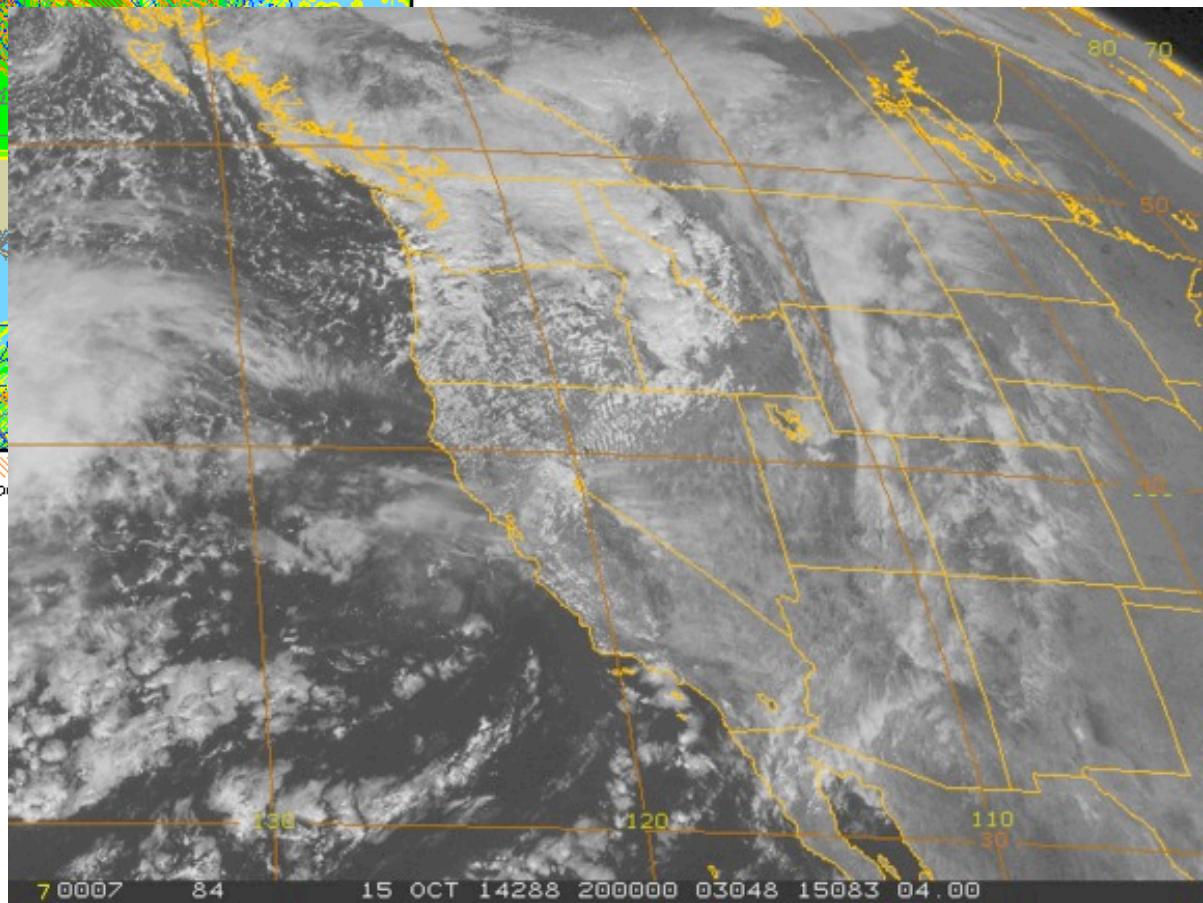
Integrated liquid and frozen hydrometeors (all levels)





Integrated liquid and frozen hydrometeors (all levels)

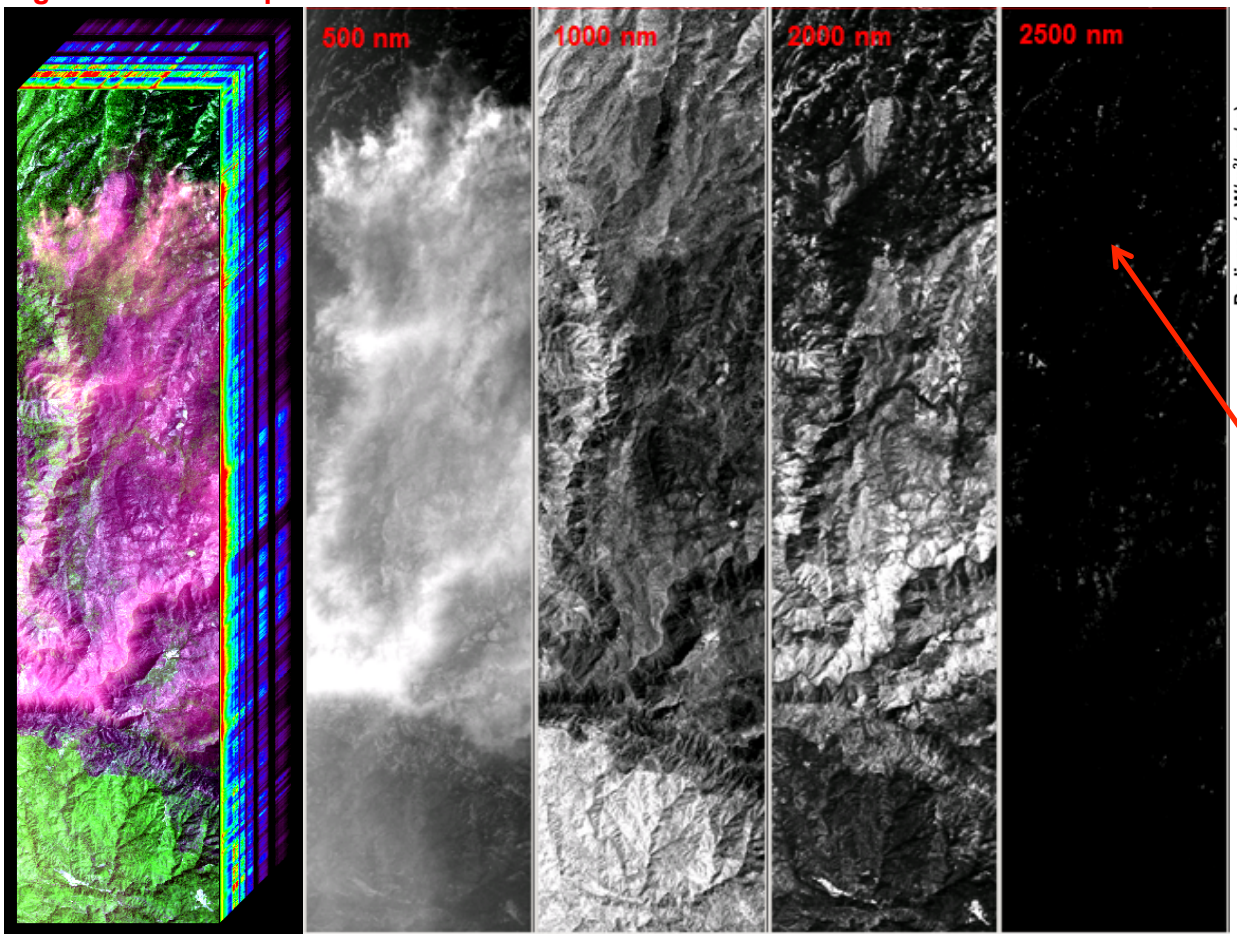


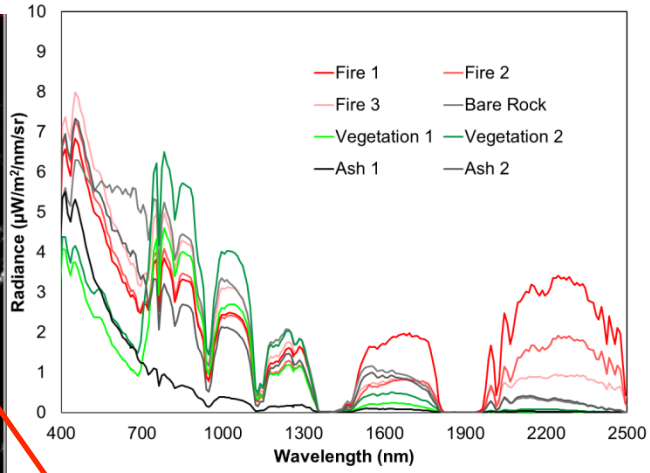


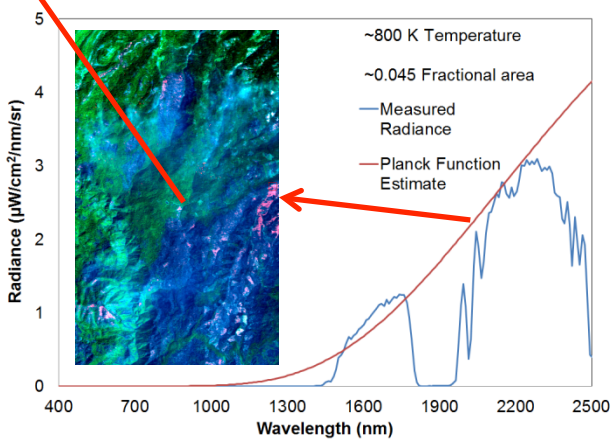
HyspIRI Preparatory Campaign
AVIRIS Rim Fire 130913 Flight Line #5

- As part of the HyspIRI Preparatory Airborne Campaign, AVIRIS obtained VSWIR spectroscopic coverage of the full RIM fire area on the 13th of September.
- VSWIR spectroscopy is used to measure fuels (species-type, water, dry biomass, etc.), hot fire temperature, smoke properties, severity and recovery processes.

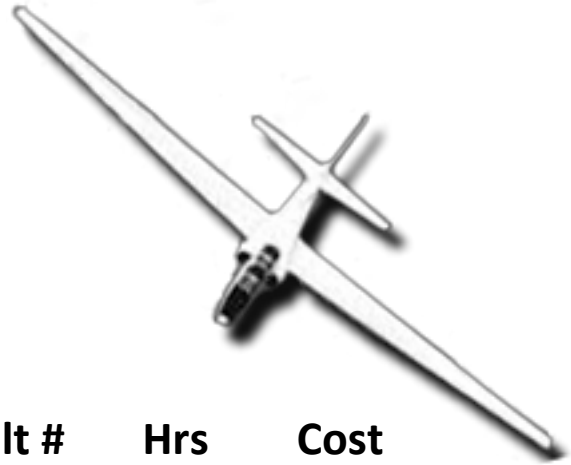
Flight line #5 Example







Planned 2013 Flight Windows
Mar 20 - April 22
May 22 - June 10
Sept 9 – 20 /Oct 7 - 18



FY13 Flight Activity	Date	Flt #	Hrs	Cost
132003 - HyspIRI	4.10.13	13-9037	6.5	$22,750
132003 - HyspIRI	4.11.13	13-9038	5.7	$19,950
132003 - HyspIRI	4.12.13	13-9039	8.5	$29,750
132003 - HyspIRI	4.19.13	13-9040	7.6	$26,600
132003 - HyspIRI	5.2.13	13-9041	4.4	$15,400
132003 - HyspIRI	5.3.13	13-9042	4.3	$15,050
132003 - HyspIRI So Cal Box	5.22.13	13-6021	7.6	$26,600
132003 - HyspIRI So Cal Box Night Flight & PowerStation Fire	6.1.13	13-6026	1.1	$3,850
132003 - HyspIRI Tahoe Box	6.4.13	13-6027	4.7	$16,450
132003 - HyspIRI Santa Barbara Box & Soda Straw	6.6.13	13-6028	6.7	$23,450
132003 - HyspIRI	6.7.13	13-6029	6.7	$23,450
132003 - HyspIRI	6.10.13	13-6030	1.5	$5,250
132003 - HyspIRI	6.26.13	13-6037	4.9	$17,150
132003 - HyspIRI Rim Fire	9.13.13	13-6045	2.6	$9,100
132003 - HyspIRI Tahoe Box	9.19.13	13-6048	5.7	$19,950
132003 - HyspIRI So Cal Box	9.24.13	13-6049	7.6	$26,600
		FY13 Totals	**86.1**	**$301,350**

HyspIRI Airborne Preparatory Mission Fall 2013 Campaign Dates

September 16 – 27, 2013

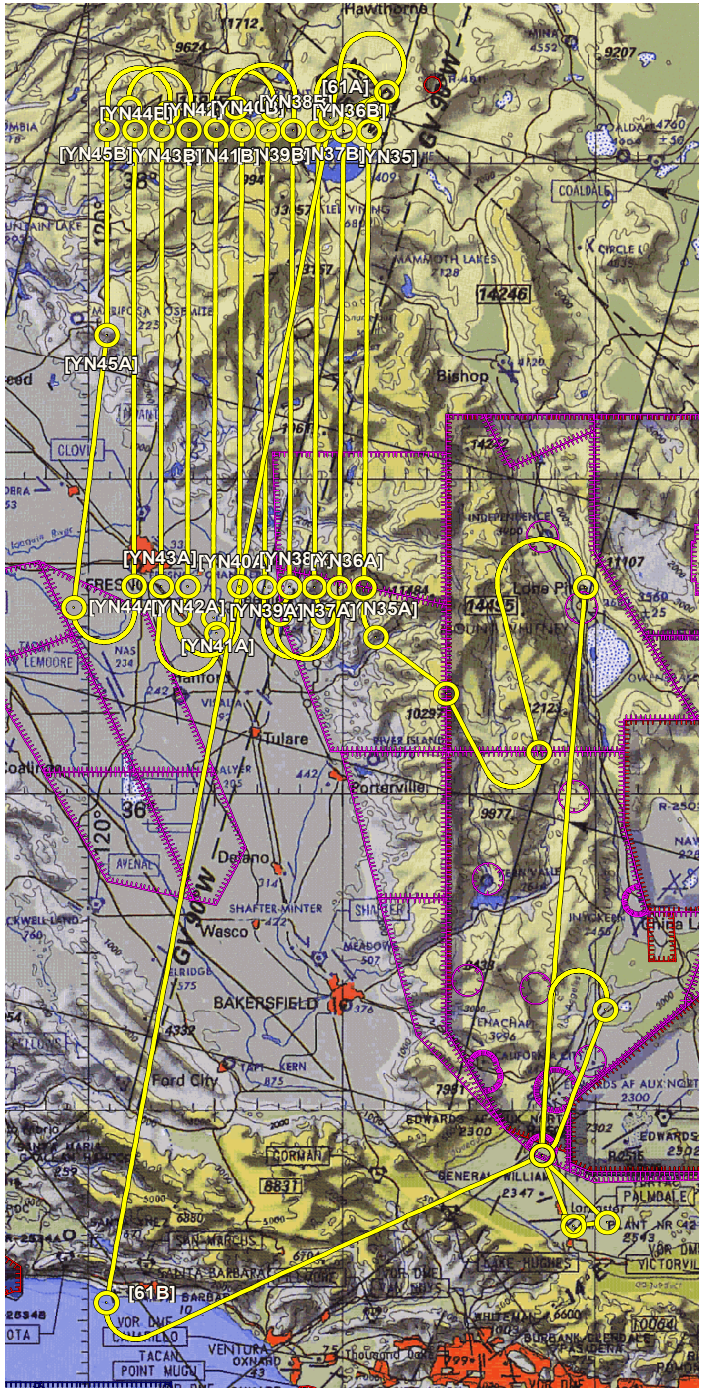
- Contingency Flights Oct 1-3
- Targets flown:

1. Rim Fire
2. Southern California Box
3. Tahoe Box
4. AVIRIS Vicarious Calibration Experiment at Ivanpah

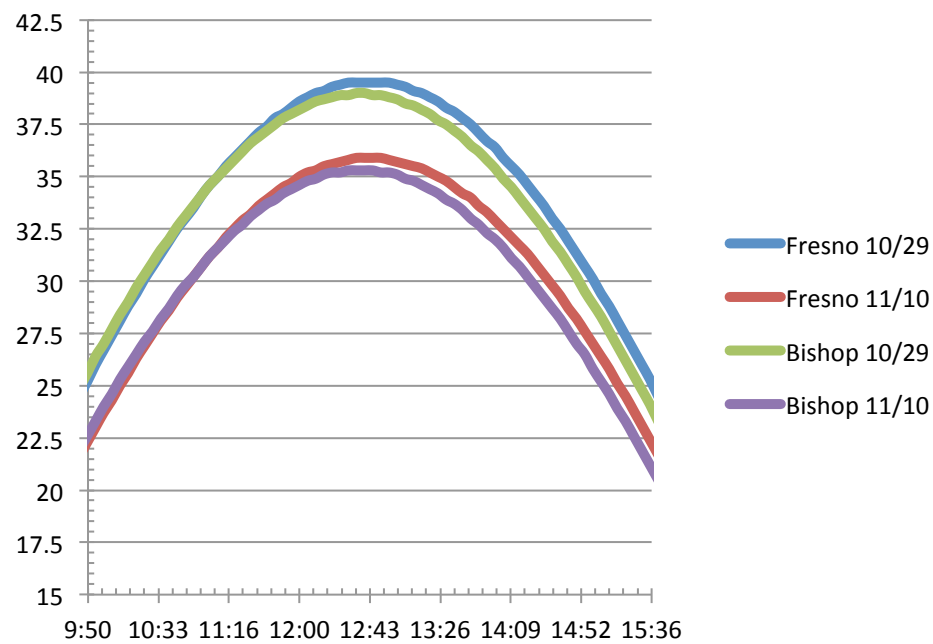
October 29- November 14, 2013

- Contingency Flights Oct 21-25
- Targets to be flown:

1. SF/Monterey Bay Box
   - With OCEANIA Flights on the CIRPAS Twin Otter
2. Santa Barbara Box
   - Plumes and Blooms Cruise on October 17
3. Yosemite/NEON Box
4. Mtn Pass



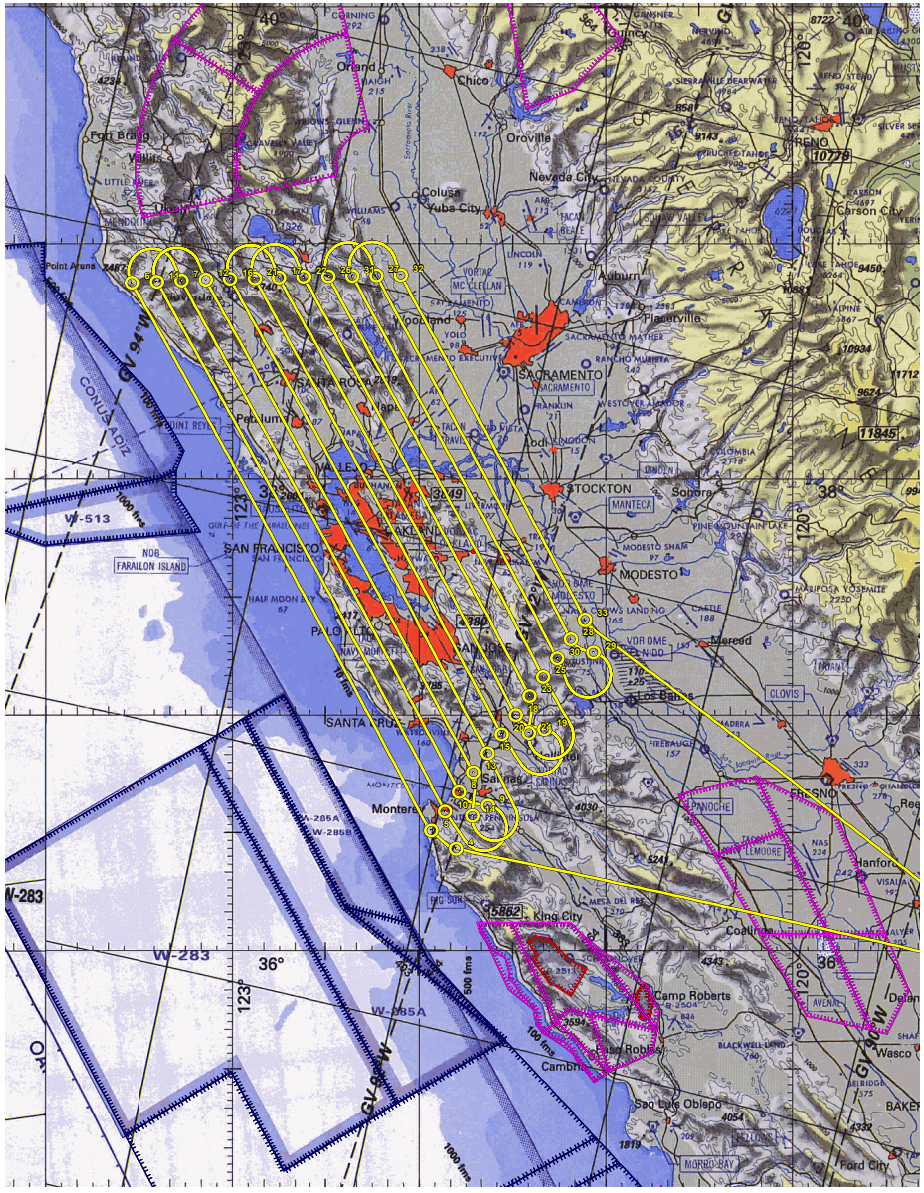
- Yosemite/NEON
- 3.5 hours of collection

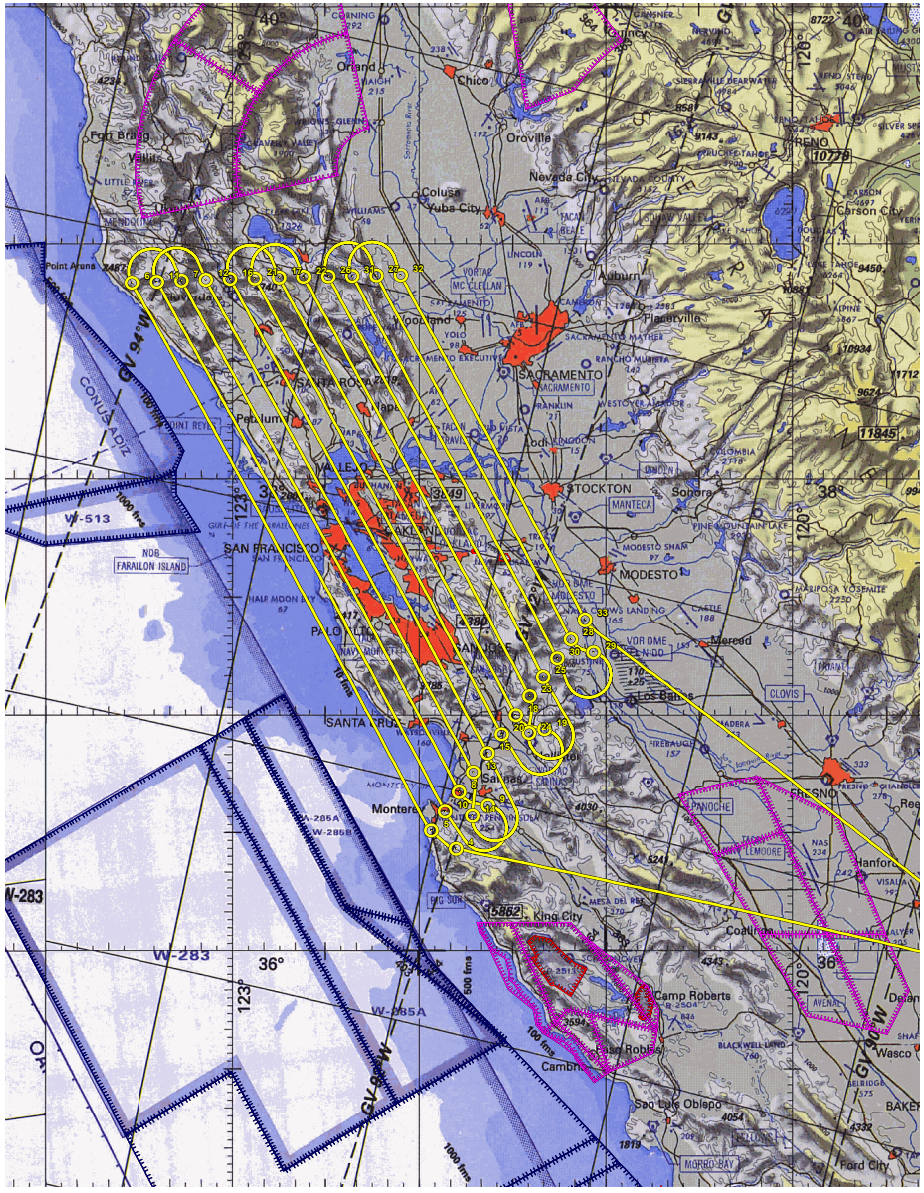


April 10, 2013 – San Francisco Bay - 6.5 hours

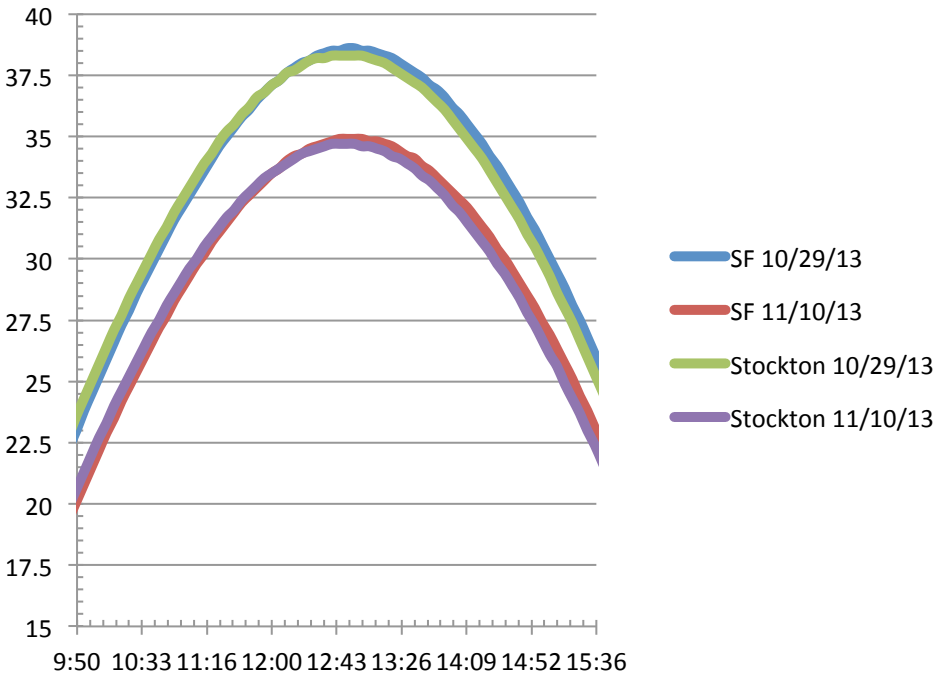
UCSC and Ames Team on R/V Martin in Monterey Bay – Sonoma State in Bay Area

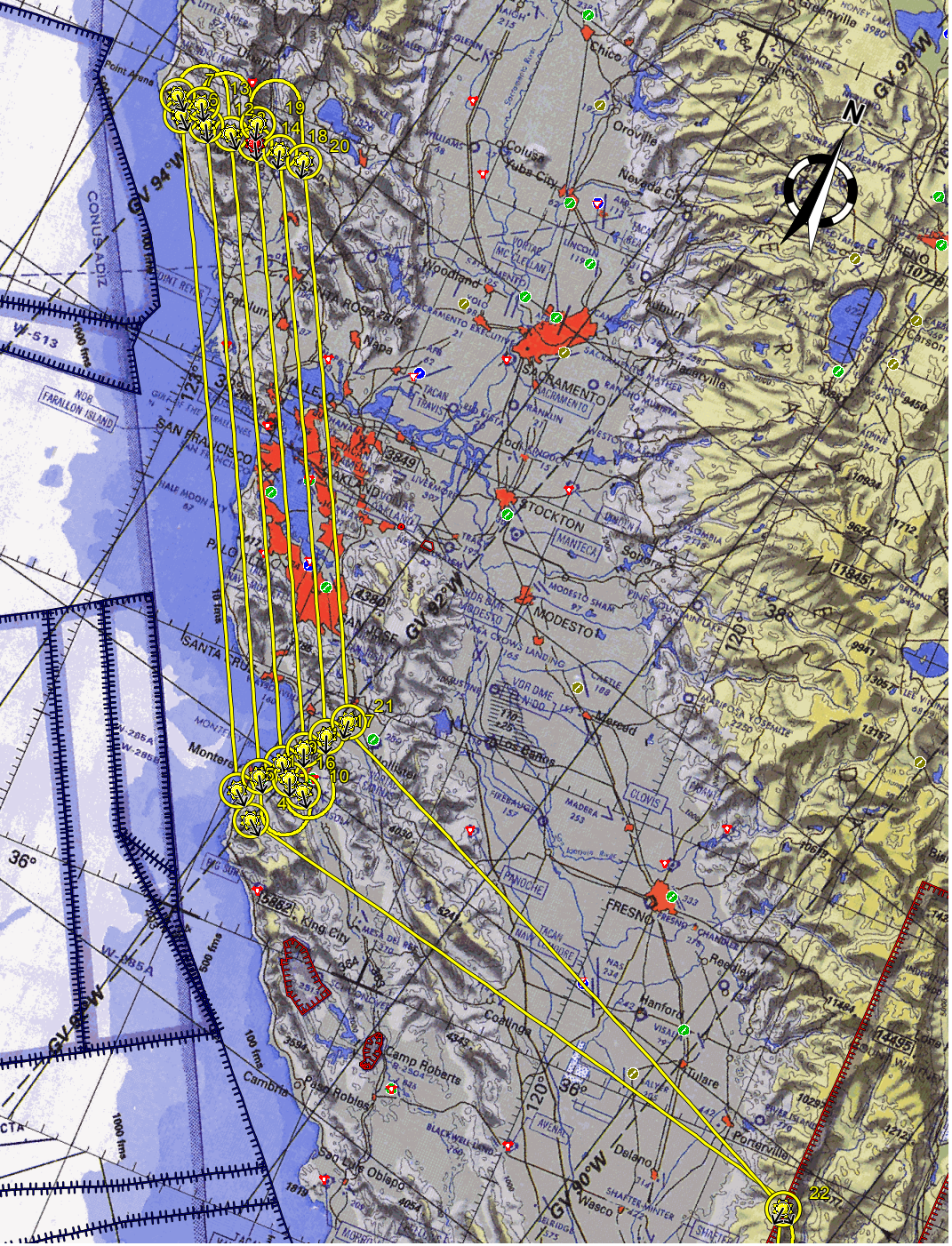
UCD in Sacramento Delta


SACRAMENTO
STOCKTON
MODESTO
SAN FRANCISCO
SANTA CRUZ
Monterey
Salinas
King City
Camp Roberts
Paso Robles
San Luis Obispo
Chico
Oroville
Nevada City
Auburn
Placerville
Yuba City
Colusa
Petaluma
Point Arena
Point Reyes
Ukiah
Napa
Oakland
Merced
Los Banos
Coalinga
Hanford
Visalia
Fresno
Clovis
Madera
Lemoore
Reno
Carson City
Quincy
Orland
Fort Bragg
Ukiah
Sonora
Manteca
Ceres
Modesto
Ford City
Morro Bay
Cambria
Wasco
Delano
Arcata
Eureka
Crescent City
Redding
Yreka
Alturas
Susanville
Truckee
Tonopah
Bishop
Mammoth Lakes
Lake Tahoe
Mono Lake
Death Valley
Farallon Islands
Half Moon Bay
Pacific Ocean
W-283
W-285A
W-285B
W-513
GV 94°W
GV 92°W
GV 90°W
GV 88°W
GV 86°W
GV 84°W
GV 82°W
GV 80°W
GV 78°W
GV 76°W
GV 74°W
GV 72°W
GV 70°W
GV 68°W
GV 66°W
GV 64°W
GV 62°W
GV 60°W
GV 58°W
GV 56°W
GV 54°W
GV 52°W
GV 50°W
GV 48°W
GV 46°W
GV 44°W
GV 42°W
GV 40°W
GV 38°W
GV 36°W
GV 34°W
GV 32°W
GV 30°W
GV 28°W
GV 26°W
GV 24°W
GV 22°W
GV 20°W
GV 18°W
GV 16°W
GV 14°W
GV 12°W
GV 10°W
GV 8°W
GV 6°W
GV 4°W
GV 2°W
GV 0°W
GV 2°E
GV 4°E
GV 6°E
GV 8°E
GV 10°E
GV 12°E
GV 14°E
GV 16°E
GV 18°E
GV 20°E
GV 22°E
GV 24°E
GV 26°E
GV 28°E
GV 30°E
GV 32°E
GV 34°E
GV 36°E
GV 38°E
GV 40°E
GV

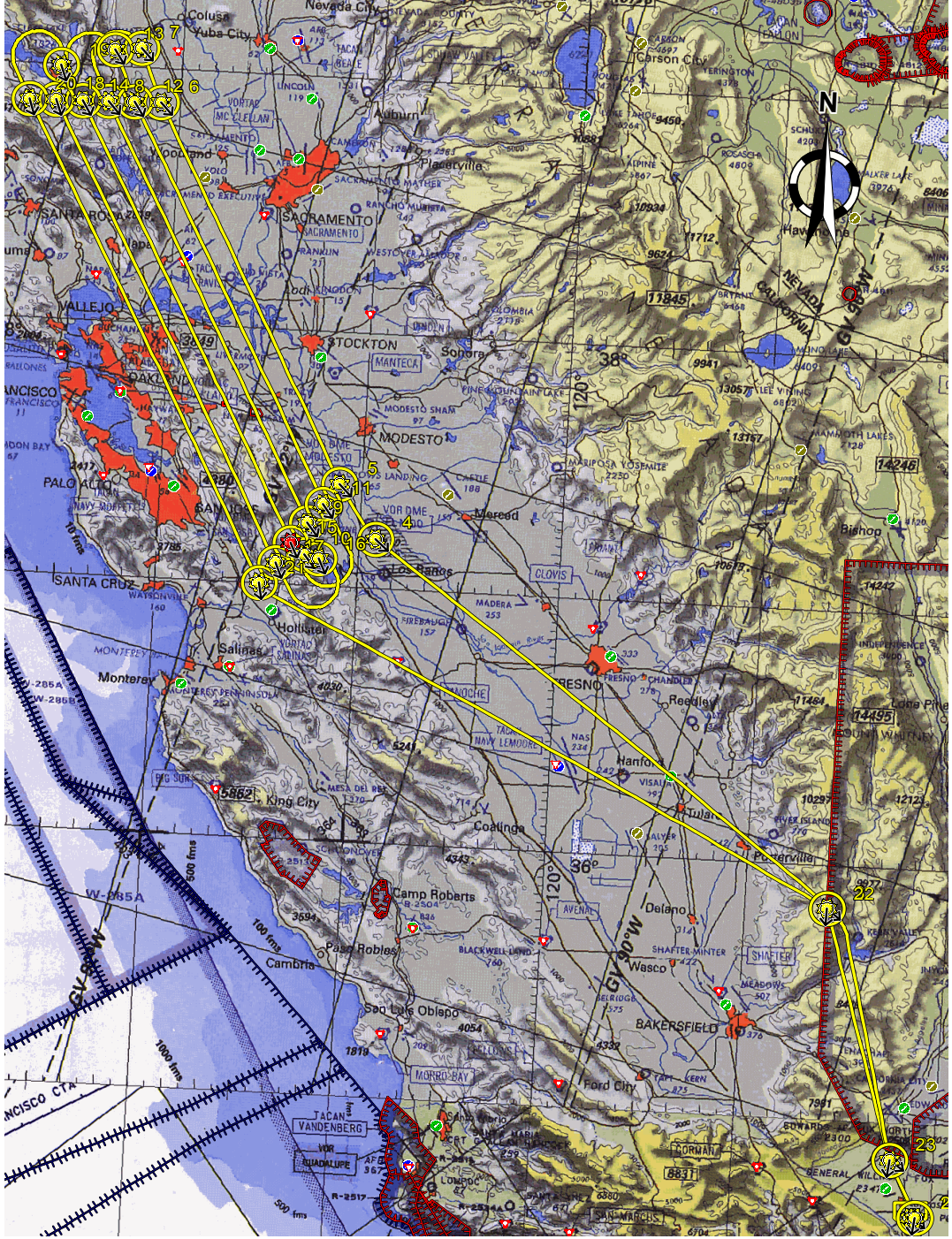


- Bay Area Box
- 5 hours of collection



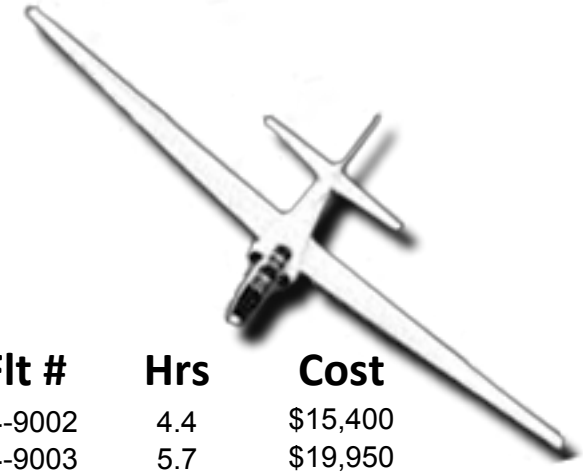


- Bay Area Box West
- 2.5 hours of collection



- Bay Area Box East
- 2.5 hours of collection

Planned 2014 Flight Windows
Spring: April 1 – 30, 2014
Early Summer: June 1 – 15, 2014
Late Summer: Aug 15 – 30, 2014
Fall: Sept 15 – Oct 15, 2014



FY14 Flight Activity	Date	Flt #	Hrs	Cost
ACOCO & HyspIRI West SF Bay Box	10.31.13	14-9002	4.4	$15,400
HyspIRI Yosemite + 2 Rim fire lines	11.05.13	14-9003	5.7	$19,950
HyspIRI SoCal line, Soda Straw, Mt. Pass, & 4 Yosemite lines	11.17.13	14-9005	2.8	$9,800
HyspIRI SoCal line, Soda Straw, Mt. Pass, & 4 Yosemite lines	11.17.13	14-9005	2.0	$7,000
HyspIRI SF East Box (partial - avoided cloudy regions)	11.22.13	14-9006	5.2	$18,200
HyspIRI Santa Barbara	11.25.13	14-9007	5.1	$17,850
HyspIRI SB and SF cleanup	12.04.13	14-9012	4.9	$17,150
HyspIRI San Francisco cleanup	12.05.13	14-9013	4.6	$16,100
HyspIRI Yosemite & Soda Straw	04.07.14	14-6030	5.8	$20,300
HyspIRI Tahoe	04.10.14	14-6031	5.2	$18,200
HyspIRI So Cal Box & 2 Ecohab lines	04.14.14	14-6032	8.0	$28,000
HyspIRI Santa Barbara Box	04.16.14	14-6033	6.0	$21,000
HyspIRI - BA Box (only 6 Eastern lines due to Clouds)	04.18.14	14-6034	4.0	$14,000
HyspIRI - Bay Area (with extended lines for AirMSPI)	04.28.14	14-6037	7.6	$26,600
HyspIRI - Bay Area	05.07.14	14-6038	6.9	$24,150
HyspIRI Bay Area Box	05.28.14	14-6041	6.7	$23,450
HyspIRI Tahoe Box	06.02.14	14-6043	5.1	$17,850
HyspIRI Yosemite/Neon Box & Soda Straw	06.03.14	14-6044	6.3	$22,050
HyspIRI Santa Barbara Box	06.04.14	14-6045	5.8	$20,300
HyspIRI So Cal Box	06.13.14	14-6048	7.7	$26,950
HyspIRI - So Cal Box	08.26.14	14-9039	7.8	$27,300
HyspIRI - So Cal Box Night Flight (4 Lines)	08.28.14	14-9040	3.7	$12,950
HyspIRI Santa Barbara Box	08.29.14	14-9041	5.1	$17,850
HyspIRI Tahoe Box and King & Irene Fires	09.19.14	14-6065	5.5	$19,250
		FY14 Totals	**131.9**	**$461,650**

HyspIRI Airborne Preparatory Mission CY 2015 Campaign Dates

- Spring: April 6 – 30, 2015
- Early Summer: June 1 – 12, 2015
- Late Summer: Aug 17 – 28, 2015
- Fall: Sept 14 – Oct 31, 2015

We have 144.1 hours remaining to finish CY 2014 and complete FY 2015 HyspIRI work.

WARNING
SIDE AIRBAG